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HARRY A. COCHRAN, Dean
JOHN F. ADAMS
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The reader's appraisal of the **Bulletin** and comments upon it are solicited. The Bureau also will appreciate receiving suggestions and requests for particular studies.

The opinions and views expressed in the articles contained in this **Bulletin** are those of the writers and cannot be construed as the official opinions or policies of the School of Business.

The Dilemma of the P. T. C.

by WM. J. McKENNA*

The Philadelphia Transportation Company is confronted with a serious dilemma: How can it maintain adequate transportation service in the face of a persistent decline in passenger travel and ever-rising costs? The perplexing problem of an inadequate rate of return resulting from long rate-lags and bitter municipal opposition to rate increases necessary to secure a compensatory rate have worsened its position. Alternatives to rate increases must, of course, be thoroughly explored, but the ultimate result of noncompensatory rates will be reduction of capital expenditures and service, severe impairment of its financial position, or receivership and reorganization. Eventual municipal owership may result from this situation without in any way correcting the basic illness of the urban transportation industry of Philadelphia. The City of Philadelphia may then inherit the dilemma of the Philadelphia Transportation Company.

URBAN transportation companies throughout the nation are confronted with a serious dilemma: how can they continue to render efficient, safe, and extensive service at a low rate, and at the same time receive an adequate return for the services they render. The Philadelphia Transportation Company is no exception; this company, in keeping with the trend in all major cities in the United States, is faced with continuously rising costs of operation but persistent declines in street-railway travel.

This situation is the result of several long-run factors over which the Philadelphia Transportation Company has no control. These factors include: (1) the declining nature of urban transportation as an industry, (2) the use of the automobile, (3) the movement of people along with the related move of department store branches, super markets and other consumer service industry to the suburbs, (4) the shortening of the workweek to five days, (5) the dispersion of industries, (6) the rise of television, and (7) increasing wage and capital equipment costs.

SPECIFIC LONG-RUN FACTORS OF DECLINE

It is the combined impact of the seven factors shown above which constitutes the major problem of the P.T.C. Together, they have reduced the relative and absolute importance of urban public transportation. Evidence of this decline, which has been general, is presented in Table 1. It appears from an examination of the data that the normal peak of urban public transportation travel was reached in the United States in 1926 when a total of 17.2 billion passengers were carried. Since that date there have been two distinctly abnormal circumstances accounting for deviations in the trend.

First, the decline during the depression is not representative of the trend; second, the sharp rise of the war years due to abnormal restrictions could not be taken as significant of a reversal of trend, particularly in view of experience following the cessation of hostilities. It seems apparent that the rapid growth of automobile travel following 1926 marked the end of the long period of growth to which this industry had been subject. Even after all of the wartime expansion and the great increase in total population between 1926 and 1950, the number of persons carried by urban public transportation was about the same in both years. It seems evident that the trend is likely to be resumed when a normal nonwar economy is restored.

At the same time that this overall de-

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*Wm. J. McKenna is a member of the Transportation and Economics Faculties of the **Temple University** School of Business and Public Administration.

TABLE 1

Passengers Carried in the Urban Public Transportation Industry, Selected Years 1921-1950[1]
(In millions)

Year	Electric Railways	Trolley Coaches	Buses	Total
1922	15,331	....	404	15,735
1926	15,225	....	2,009	17,234
1930	13,072	16	2,479	15,567
1934	9,600	68	2,370	12,038
1938	8,781	389	3,475	12,645
1942	9,856	899	7,245	18,000
1943	11,806	1,175	9,019	22,000
1944	12,137	1,234	9,646	23,017
1945	12,124	1,244	9,886	23,254
1946	11,862	1,311	10,199	23,372
1947	10,852	1,356	10,322	22,540
1948	9,112	1,528	10,728	21,368
1949	8,185	1,661	10,162	19,008
1950	6,168	1,658	9,420	17,246

Source: **Moody's Manual of Investment, American and Foreign: Public Utility Securities, 1951, p. A-68.**

[1]In 1951 the total passengers carried by this industry declined to 16 billion. This was, however, above the 14 billion total of 1941. Early 1952 traffic was still declining, but at a rate less than that of 1951.

cline in passenger travel has taken place there has been a steady increase in the operating costs and taxes of all urban transportation industries. Thus, there has been a sharp drop in the total operating income of urban transportation companies in recent years. In 1935, for example, the operating income of the urban transportation industry was approximately $96 million whereas in 1950 this figure had declined to approximately $66.4 million. (See Table 2.) The abnormal travel of the war years is, of course, reflected in a large increase of income, but the 1950 figure is substantially lower in spite of rate increases

TABLE 2

Operating Revenues of all Urban Public Transportation Companies, Selected Years 1935-1950
(In millions of dollars)

Year	Operating Revenue	Operating Expenses	Net Revenue	Taxes	Operating Income
1935	$ 681.4	$ 534.9	$146.5	$50.4	$96.0
1938	700.8	579.7	121.1	65.7	53.4
1940	737.0	598.0	139.0	62.7	76.3
1942	1,040.0	769.4	270.6	126.7	142.0
1944	1,362.3	1,012.1	350.2	189.3	161.0
1946	1,397.1	1,129.4	267.7	129.0	138.7
1948	1,488.6	1,349.7	144.9	101.2	43.7
1949	1,490.9	1,338.3	152.6	88.9	63.7
1950	1,452.1	1,296.7	155.4	89.0	66.4

Source: **Ibid.**, p. A-69.

TABLE 3

Number of Employees, Annual Payroll, and Average Annual Wages of all Urban Public Transportation Employees, Selected Years 1935-1950

Year	Number of Employees (Thousands)	Annual Payroll (Millions)	Average Annual Earnings
1935	209	$321	$1,536
1939	204	356	1,745
1940	203	360	1,773
1941	205	386	1,882
1942	219	462	2,110
1943	239	554	2,318
1944	242	599	2,475
1945	242	632	2,612
1946	261	713	2,732
1947	266	790	2,970
1948	261	829	3,176
1949	253	841	3,325
1950	240	835	3,480

Source: **Ibid.**

TABLE 4

Indexes of Fares, Operating Material Costs, and Wages for the Urban Public Transportation Industry, by Type, for Selected Year 1913-1941, 1913 = 100

Year	Street Railway and Bus Fares	Electric Railway Operating Costs	Electric Railway and Bus Wages
1913	100.0	100.0	100.0
1917	100.5	191.2	120.6
1920	137.2	218.2	217.3
1923	142.9	161.0	212.1
1926	151.9	151.1	225.3
1929	157.1	143.9	230.6
1931	161.2	125.8	231.5
1933	162.5	115.6	204.5
1936	161.9	132.3	228.2
1937	161.8	147.3	237.1
1940	163.5	144.5	252.0
1941	166.3	162.0	286.5

Source: **Ibid.**

throughout the country.

One of the biggest problems of the urban transportation industry is the payment of wages. From 1923 to 1931 the wage index rose steadily. In May 1933 this index was 202% of the pre-World War 1 index. The hourly wage had risen by 1933 to 52.8 cents by comparison with 27.3 cents per hour before the first World War.[1] Since 1933 the union movement in the urban transportation industry has developed and wages in this industry have kept pace with the national trend. Steadily increasing wage costs to the urban transportation industry have been the result. Table 3 presents the general wage cost to all urban transportation companies in selected years from 1935 to 1950.

There is a strong tendency in the urban transportation industry for rate to lag behind cost charges. In almost all jurisdictions, rate schedule modifications are subject to the approval of the regulatory bodies and therefore all costs are given the most careful scrutiny by the regulatory agencies. This is as it should be. But if these regulatory agencies ignore the true increase in costs and bow to political influences, then they defeat the principal purposes of public utility regulation, viz, the assurance of a sound system of operating public utilities. Table 4 presents the index of rate levels, operating and material costs, and wages for selected years from 1913 to 1941. This index declined from 1929 to 1933 but in 1937 it rose above the 1929 level and continued to increase steadily until 1941. During World War II the abnormal increase in traffic removed the need for rate increases to meet rising costs, even though the cost trend continued upward. Since 1945, however, the rising cost trends in all phases[2] of urban public transportation have continued upward. This, along with certain other factors important in the general decline of the urban transportation industry, will be discussed in relation to their impact upon the operations of the Philadelphia Transportation Company.

[1] **Moody's Manual of Investments, American and Foreign; Public Utility Securities,** 1951, p. A-69.

[2] For example the average annual wage of all urban transportation industry employees was $1745 in 1939 and $3480 in 1950, an increase of approximately 100 percent.

THE PHILADELPHIA TRANSPORTATION COMPANY

The Philadelphia Transportation Company is the successor of the Philadelphia Rapid Transit Company which was incorporated in 1903. The P.R.T. had acquired through leases and stock ownership all the franchises of the original transportation[3] and motor traction companies[4] operative within this city, and had assumed the duties and functions provided thereby individually and collectively. As the city grew, P.R.T. expanded the transportation system by the construction of the Market Street Subway-Elevated and surface railway extensions, and provided a number of additional street railway lines.

Additional facilities were later acquired by the P.R.T. as a result of lease arrangements with the City of Philadelphia and the Delaware River Bridge Commission. These extensions were city-constructed and consist of the high-speed transit lines including: (1) the Frankford Elevated System (including the Bustleton Surface line), (2) the Broad Street Subway System, and (3) the Delaware River Bridge Line.[5]

Reorganization of P.R.T.

As a result of the severe economic depression beginning in 1929 the P.R.T. suffered a sharp decline in passengers and revenue.[6] Because it was unable to meet its fixed interest and debt service charges, a petition in the United States District Court for Eastern Pennsylvania of receivership and reorganization was filed in 1934 under 77-B of the federal bankruptcy law. The reorganization proceedings lasted until 1939 when final approval of the reorganization plan was received from all interested parties.[7]

The principal effect of the reorganization plan was to merge all separate cor-

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[3]Prior to the adoption of the Pennsylvania Constitution of 1874 all street-railway charters were granted by a special act of the legislature. Approximately 50 companies had been granted such special charters to occupy various streets of Philadelphia for the purpose of transporting passengers from point to point. The first street-railway car (a horse-drawn vehicle) was operated in Philadelphia on January 20, 1858 by the Frankford and Southwark City Passenger Railroad Company which had been incorporated on April 4, 1854. Between 1857 and 1859 a total of eighteen additional transport companies were chartered. The balance of these special charters were granted thereafter until 1874. Since that date all charters have been granted under the provisions of the general incorporation law. These companies are, for the most part, the original underliers and they, in turn, leased their franchise rights for 999 years (since their franchises were perpetual) to the various traction companies who became successor underliers.

[4]The traction companies were those which rendered motor-driven transportation service. Since they had acquired the leases and franchises of the original underliers, they were in position to lease all their properties to the newly formed Philadelphia Rapid Transit Company in 1903. The traction companies included: The Philadelphia Traction Company (formed in 1883), the Electric Traction Company (formed in 1893), and the Union Traction Company (formed in 1893). The last named had absorbed the others, including leases and rental commitments, leasing them for a period of 999 years just prior to the establishment of the new P.R.T. When the latter company was formed, it took over all the leases, properties, and rental commitments of the Union Traction Company, although the latter reserved the right to reassume control of its system if the rentals and charges were not paid under the lease agreements with the P.R.T.

[5]The Frankford Elevated has been operated by the P.R.T. (PTC) since November 5, 1922 at an annual rental of approximately $780,000 (which is equal to 5% of the cost of the construction of the system). The Bustleton extension under the agreement of August 1, 1949 is to be operated by the P.T.C. for a period of 15 years at an annual payment related to the amount of bonds outstanding (not to exceed $900,000). Since September 2, 1928 the P.R.T. (P.T.C.) has operated the Broad Street Subway under a base lease rental of $900,000 a year plus 2c for every passenger in excess of 52,000,000. By agreement this 2c is to be increased as the rate of fare increases.

The Delaware River Bridge Line has been operated since June 7, 1936 by the P.R.T. (P.T.C.) under a lease with the Delaware River Joint Bridge Commission dated February 15, 1935. The fare is the base rail fare of Philadelphia plus 2½c, which represents the rental charge per passenger. Because this line was operated at a loss, an amended agreement (July 1, 1941) was negotiated providing for reimbursement to P.T.C. from excess rentals. Full rental has, however, been paid since 1943.

[6]Deficits continued to be sustained in the following years: 1935 ($1,525,154); 1936 ($2,496,858); 1937 ($4,715,350); 1938 ($6,139,655). These deficits do not include occurred liabilities.

[7]Besides the creditors and stockholders this included the U. S. District Court for the Eastern District of Pennsylvania, the City of Philadelphia, and the Public Utilities Commission of Pennsylvania.

porate elements of the P.R.T.[8] into a new company, the Philadelphia Transportation Company. This new company began its corporate existence on January 1, 1940. The plan of reorganization resulted in a sharp decrease in the fixed charges to be paid by the newly formed P.T.C.[9]

The P.T.C. Since 1940

Funded Debt. Since 1940 the Philadelphia Transportation Company has been subject to the same ills that plague the entire urban transportation industry. It had assumed, as a result of the reorganization proceedings, a total funded debt of $61,974,238.18 as of January 1, 1940.[10] On December 31, 1940, this total debt was increased to $62,089,495.84 and consisted of: (1) real estate mortgage bonds and miscellaneous of $2,356,092.30, (2) divisional lien bonds of $20,772,200.00, (3) collateral trust bonds of $2,170,000.00, and (4) Philadelphia Transportation Company obligations of $36,791,203.54 (including equipment trust issues of $2,546,000.00 issued in 1940 for the purchase of equipment). In 1940 this necessitated direct fixed interest payments of $2,363,917.42.

Criticism is often directed at the payment of the income interest on the funded debt of the P.T.C., assumed as a result of the reorganization plan. It must be borne in mind, however, that the 3% income interest is payable only if earned during the year, a provision containing a protective feature for the P.T.C. If one considers that funded debt money for long term use cannot be secured by the urban transportation industry except at a high rate, then it is a false assumption that, even if permissible, these bonds could be refunded for a rate of interest comparable to that given electric utility industries, or industry in general.

In spite of the difficulties that have confronted the P.T.C. since its incorporation, it has been able to secure a total reduction of $12,991,539.18 in the debt outstanding on January 1, 1940. This has meant a net reduction of interest requirements of $941,847.48 over those of 1940. This has in part been achieved as a result of the issuance, since January 1, 1940, of equipment trust certificates valued at $12,778,000.00, and a $7,000,000

[8]Approximately 150 separate corporations had originally entered into the corporate structure of the P.R.T. and its underlying companies. Approximately 34 of the 150 were dissolved or otherwise disappeared during the course of the years; 33 lost their corporate identity by merger or reorganization; approximately 77 survived as underlying and subsidiary corporations of the P.R.T. (including 61 railway companies, one subway-elevated company, four traction companies, one bus company, one trackless trolley company, three taxicab companies, three real estate companies, one construction company, and two companies concerned with an amusement park. (See: Report of the Transport Advisory Committee to General Conference on Transit Situation in Philadelphia, 1930, pp. 15-16.)

[9]Rental and interest obligations of the P.R.T. in 1929 included: to original underliers, $2,858,148.65; to original traction company, $2,814,549.80; to Union Traction Company, $1,844,344.23; to other leased companies, $565.927.87; to Chester and Philadelphia Railway Company, $81,489.08, and to P.R.T. collateral bonds, $745,246.68. This amounted to $8,909,706.31, the overwhelming portion of which was for rentals.

[10]Much criticism has also been levied against the P.T.C. for the assumption of such a heavy debt. It is claimed by some that this debt represents much "wind and water" and should therefore not be considered in full in determining the rate level allowed. But it must be borne in mind that during the long reorganization proceedings other plans would have been even harsher on the P.T.C. The creditors of the P.R.T. possessed legal rights which could not be extinguished by mere fiat. The final reorganization plan was a compromise of many interests, and was accepted, however reluctantly, by all parties concerned. To accept the over-evaluation criticism would be to substitute the view of the critics for that of the court and P.U.C. in the reorganization proceedings.

TABLE 5

Capital Expenditures by the P.T.C. for New Equipment after January 1, 1940[1]

Year	Amount
1940	$ 1,390,871
1941	4,993,815
1942	2,866,558
1944	82,393
1946	153,289
1947	8,073,592
1948	4,904,540
Total	$22,465,058

Source: **Philadelphia Transportation Company, Annual Reports, 1940-1950.**

[1]No equipment was purchased in 1943 or 1945.

TABLE 6

P.T.C. Equipment on Hand on February 1, 1945 and 1952

	Cars	Trackless Trolleys	Buses	Subway-Elevated Cars	Total Units
1945	1902	74	756	541	3273
1952	1692	167	939	541	3339

Source: **Ibid.** Some additional information was obtained from an interview with officials of the Company.

first and refunding issue of P.T.C. 3¾% refunding bonds. Of the equipment trust certificates issued, $8,616,000.00 had been redeemed by December 31, 1951. As of December 31, 1951, the total funded debt in the hands of the public was $49,076,500.[11]

Capital Expenditures for New Equipment. During the prolonged period (1934-1939) of reorganization there was little new transit equipment acquired. This resulted in an increase in maintenance costs, and a deterioration of service. During the period 1940-1948 the P.T.C. spent $22,465,058 for the purchase of new equipment. This purchase included 450 cars at a total cost of $9,506,358; 131 trackless trolleys, costing $1,982,079; and 891 buses costing $10,976,621. Table 5 contains a breakdown of this equipment purchase by years.

Part of this equipment fund was secured through depreciation reserves, part from re-invested earnings, and part through the issuance of equipment trust certificates. A breakdown of the equipment on hand as of February 1, 1945, and February 1, 1952, is presented in Table 6.

Wages. In the urban public transportation industry wages constitute the principal item of cost. This cost has risen in the case of the P.T.C. from a total of $17,000,000 in 1940 to $45,844,000 in 1951.[12] The principal wage increase came after World War II although wage costs had increased substantially during the war.[13] During the period of February 11, 1946, to December 16, 1951, the average hourly wage increases have totaled 68c. (See Table 7.)[14] The number of employees and their hourly wage in 1951 is substantially above that of 1940 and their total wages constitute an increasing percentage of gross revenue, as is shown in Table 8.

[11]Reduced to $48,982,700 by payments made in January 1952. Funded debt maturing in 1952 will amount to $900,000.

[12]Including pensions and other payments to employees.

[13]On January 1, 1941 the wage rate of one-man car operators was raised from 80c to 83c an hour, and that of high-speed motormen from 78c to 83c an hour in order to equalize their hourly rate with that of bus operators. Effective August 1, 1941 a 6c per hour wage increase was granted to all employees as a cost-of-living increase. A further increase of 2c an hour became effective on January 1, 1942. On February 11, 1943 the National War Labor Board ordered a wage increase of 4c an hour retroactive to August 10, 1942. In 1943 wage allowances were awarded men on certain swing runs, and those working on the seventh day in a calendar week. Incentive wage arrangements in 1944 further increased wage costs. In 1945 a "War Victory Bonus" of $65.00 was awarded by the War Labor Board to each employee.

[14]The present Union contract provides that P.T.C. employees be given a cost-of-living wage adjustment in accordance with changes in the "Consumer's Price Index for Moderate Income Families in Philadelphia-All Items" published by the Bureau of Labor Statistics, 1935-1939 ± 100). These adjustments are to be made June 15 and December 15 of each year. The table of wage adjustment provides for a two cent adjustment for each 2.46 point change in the index according to the following table:

Six Months Past Average of Index	Cost-of-Living Adjustment Effective for Six Months' Period
173.8-176.2	0
176.3-178.6	2¢
178.7-181.1	4¢
181.2-183.5	6¢
183.6-186.0	8¢
186.1-188.5	10¢
188.6-190.9	12¢
191.0-193.4	14¢

In no case, however, is the wage level to go below that in existence December 15, 1950 (See: Agreement of December 21, 1951, as modification of comprehensive agreement of September 12, 1950.)

TABLE 7

Hourly Wage Increases of P.T.C. Employees, 1946-1951

Date of Wage Increase	Increase Per Hour
February 11, 1946	12¢
February 11, 1947	13¢
February 11, 1948	15¢
February 11, 1949	8¢
February 11, 1950	2¢
December 15, 1950	10¢
June 17, 1951	6¢*
December 16, 1951	2¢*
Total (1946-1951)	68¢

Source: **Ibid.** See also the Union-Management Agreements between the P.T.C. and T.W.U.

*These sums represent a cost-of-living wage increase under the union contract of 1950.

The charge is often hurled at the P.T.C. that "management salaries are too high. If it weren't for that, no rate increase would be necessary." This statement is utterly without foundation. If the entire sum of salaries and fees paid all executive officers and directors in 1951 were eliminated, it would have meant a one per cent in the total yearly payroll.[15] Competent management is a vital need in all industries, and the salaries of the P.T.C. management in no way can be construed as excessive when compared to those in other businesses having comreduction of approximately one-half of

[15]According to the P.T.C. proxy statement of March 4, 1952 the President of the P.T.C. received $42,500 in salary and fees in 1951, and the only other executive officer receiving over $25,000 yearly was the executive vice-president, R. F. Tyson, who received $32,500 in salary and fees. The total paid all other directors and officers as a group was $202,188.84 (compared to $169,108.71 in 1941). The salary of President Ebert in 1951 is actually less than the $50,000 paid Dr. A. A. Mitten as chairman of the Board of Directors in 1928, and to Mr. R. T. Senter, President of the P.T.C. in 1928. This $50,000 salary was reduced to $25,000 by the trustees in the receivership fund of 1934-1939. The salary of President Ebert was increased to $26,250 in 1941 and thereafter gradually has been increased to the 1951 level.

In 1952 the salaries of officers have been increased to the following: President, C. E. Ebert, $47,500; executive vice-president, R. F. Tyson, $36,000; vice-president operation, Robert H. Stier, $27,500; vice-president industrial relations, Wm. J. MacReynolds, $22,000; vice-president and comptroller, Frederic E. Benton, $16,500; vice-president, public relations, David N. Phillips, $16,000; Secretary, H. W. Barndt, $12,500; Treasurer, A. N. Hinkel, $12,000; Auditor, H. R. Ottley, $12,500. (See: Schedule No. 8, Sheets 1-3 filed before the P.U.C. of Pennsylvania on February 29, 1952.) These increases will not materially change the percentage relationship of executive salaries to total wages.

TABLE 8

Gross Revenue, Payroll, Payroll as a Percent of Gross Revenue, Hourly Wage, and Number of Employees of the P.T.C., 1940-1951

Year	Gross Revenue (Millions)	Total Payroll[1]	Payroll as % of Gross Revenue	Wages per Work-Hour	Number of Employees on Dec. 31
1940	$34.0	$16.9	49.7%	$.81	9,980
1941	38.0	18.4	48.5	.83	10,555
1942	49.2	23.1	47.0	.97	11,366
1943	57.1	26.5	46.5	.98	11,149
1944	56.3	28.9	51.3	1.10	11,491
1945	57.7	31.4	54.4	1.19	11,897
1946	59.2	35.1	59.3	1.23	12,620
1947	63.3	38.0	59.9	1.40	12,943
1948	67.9	41.7	61.4	1.60	12,431
1949	64.0	41.2	64.4	1.69	11,935
1950	66.9	42.2	63.1	1.81	11,932
1951	73.2	45.8	62.6	1.89	11,735

Source: **Ibid,** 1949 (1940-49 financial data); various years for other data.

[1]Includes vacations, pensions, sick benefits, etc.

TABLE 9

Annual Rental Payments made by the P.T.C., 1940-1951

Year	Broad-Street Subway[1]	Frankford Elevated	Bustleton Line	Delaware River Bridge Line
1940	$ 491,509	$784,242	.....	$116,398
1941	646,613	784,242	.....	105,606
1942	990,358	784,242	.....	106,840
1943	1,411,646	782,955	.....	204,499
1944	1,310,363	776,112	.....	205,685
1945	1,418,649	780,469	.....	213,462
1946	1,447,597	780,469	.....	238,971
1947	1,506,937	780,469	.....	251,424
1948	1,456,515	780,470	.....	255,237
1949	1,134,054	780,966	.....	231,880
1950	1,045,446	783,626	$31,455	221,928
1951	1,337,584	786,432	65,271	207,394

Source: **Ibid.**, 1940-1951.

[1]Represents payments in excess of the fixed annual rental of $900,000.

parable gross revenue.[16].

Nonwage Costs. These costs have risen considerably in the last decade. In 1941 a total of $5,070,103 was spent for electricity, gasoline, materials and supplies. By 1951 the figure for the same items totaled $13,453,000.[17]

Rentals. The P.T.C. pays as lessee a yearly rental to the City of Philadelphia and the Delaware River Bridge Commission for the use of the high-speed facilities built by the city and the commission. The rental payments to the city and the commission were fixed.[18] The agreement provided for a minimum payment to the city by P.T.C. of $900,000 for the use of the Broad Street Subway, which figure has been increased by operation of the provision requiring an adjustment for fare increases. When the basic fare was increased on February 18, 1947, from 7½¢ to 8¾¢ the city's excess rental per passenger increased from 2¢ to 2⅓ cents.[19] Subsequent increases in the basic rate have increased the city's excess rental per passenger to 3-5/9 cents.[20]

The rental paid by the P.T.C. on the Frankford lines is fixed yearly at approximately $780,000[21] and that of the Bustleton line varies with the amount of bonds issued by the city to provide reconversion of the line from trolley to buses.

The rental payment by the P.T.C. to the Delaware River Bridge Commission is also on a yearly basis. In 1951 it amounted to $207,394. The annual rental payments made by the P.T.C. from 1940 to 1951 are found in Table 9.

It is sometimes contended that the

[16]In a schedule filed with the P.U.C. of Pennsylvania on February 29, 1952, the P.T.C. listed "salaries and expenses of general officers" as $543,022 for the year ending January 31, 1952. This, of course, would include officials not listed in the proxy statement as "directors and officers". Even this sum is approximately one percent of the total payroll. (Schedule No. 6-A, Sheet 6 of 7.)

[17]P.T.C. annual payrolls for 1941 and 1951.

[18]See footnote 5.

[19]The provision required the addition of 4/15 of any increase in basic fare over that charge in 1929 for passengers in excess of 52 million.

[20]The 1948 increase of 1¼c in basic fare and city's excess per passenger became 2-2/3c; 1950 increase was 1¼c in basic fare and city's share became 3c; 1951 increase in basic fare was 2-1/12c and city's share became 3-5/9 cents. If the 1952 rate becomes effective the payment to the city will increase from 3-5/9c to 4c per excess passenger.

[21]This sum has been increased from the $156,039.92 paid in 1923 by graduated percentages, i.e., 1% of inventoried cost in 1924 to 5% in 1929 and later to $780,199.62 in 1929. Subsequent rentals approximate the 1929 figure.

rental paid by the P.T.C. for the use of the city-owned rapid transit facilities is insufficient to pay the full carrying charges of the debt created by the construction of such lines. The total cost of constructing the city-owned lines now in operation was $155.7 million. An additional $31 million has been invested by the city in lines which are not yet in operation, and a further city expenditure of $21 million will be made to complete the city investment in the rapid-transit system of Philadelphia. Bonds outstanding (including unspent appropriations) are approximately $125 million. An annual interest payment of approximately $4.5 million, and the annual retirement of this debt at present is approximately $2.8 million. This is a yearly total of approximately $7.3 million debt charge. The City of Philadelphia receives a total of approximately $4 million ($3 million payment for rentals of the leased subway and elevated lines, and $1 million in payments under the agreement of 1907). The City, therefore, pays out yearly approximately $3 million more than it takes in in rentals and payments. Although the contention is correct, it ignores the patent fact that were such facilities self-liquidating in character they would be built and paid for by the P.T.C. itself. They are constructed by the city because of the inherent advantages that accrue to the city from their construction, i.e., increased taxation from increased property values,[22] development of rim areas of city, increased influx of shoppers, increase of city population, increased development of industrial and business areas. These should, in all fairness, be regarded as an indirect return to the city for its investment in high-speed transit facilities.

In addition to the above rentals paid for the use of specific property, the P.T.C. yearly makes payments to the city under the 1907 agreement. These payments include at the present time: (1) $30,000 monthly for the City Treasurer;[23] (2) $700,000 yearly in lieu of paving, license fees and other obligations of the company to the city.[24]

RATES

The main points on the subject of rates are: (1) rate base, (2) rate of return, 3) rate levied.

Rate Base. It must be clearly understood that for rate-making purposes the regulatory bodies consider the rate base as the property operated by a public utility for the purpose of rendering a direct transportation service. The value of bonds and stocks have no direct bearing upon this operating property valuation.[25] The P.U.C. has the authority to determine the rate base for rate-making purposes, and if it denies a rate increase it must defend its denial by a determination of the existing base. This it did in connection with the rate proceedings of 1941-42.[26] The P.U.C. in those pro-

[22]See: Report of Transit Advisory Committee, **op. cit.**, pp. 62-63, for the effect of the projection of the Market Street Subway from 1900-1912 upon property values (an estimated increase in valuation of $432 million); increased valuation of property served by the Broad Street Subway by 1927 was estimated to be $134 million. Further increases in real estate valuation due to the construction of the Broad Street Subway were estimated to be $196 million. Applying the $2.70 tax rate of that time this increase valuation would result in over $5.25 million yearly on the Broad Street property alone.

[23]1907 Agreement, Article 9, as amended December 20, 1932.

[24]1907 Agreement, Article 10: "Lien and satisfaction of all obligations and liability on the part of the company and its subsidiary companies for the paving, and repair of the streets occupied by their surface lines, the obligation of . . . the removal of snow therefrom, and all license fees with respect to the cars run upon said streets or over the various city bridges or the system of operating said cars. . . . "

[25]If, however, the bonds and stocks contain (as Commissioner Beamish of the Pennsylvania Public Utility Commission was fond of pointing out) "wind and water" and thereby result in an excessive evaluation and interest payments, then this situation is sometimes given consideration in rate proceedings. In the P.T.C. rate proceedings of 1941-42 Commissioner Beamish contended that the P.U.C.'s evaluation of P.R.T. property for the reorganization proceedings of 1934-39 was the result of a compromise and was not binding upon the P.U.C. in 1942. (See P.U.C., C.13608, Books 1-4 of Testimony, pp. 14, 16, and 78.)

[26]The P.T.C. had filed for a rate increase in 1941, and it was suspended by the P.U.C.. In the hearings that followed the P.T.C. dropped its request for a rate increase because of the war-traffic, but it requested a rate base evaluation and a determination of a fair rate of return by the P.U.C.

ceedings estimated the rate base of the P.T.C. to be $77,000,000.[27] This decision of the P.U.C. was appealed to the Superior Court of Pennsylvania by the P.T.C. This court in a decision handed down in 1944 reversed the findings of the P.U.C. and held that a fair base for the P.T.C. was $93,000,000.[28] The Court held that the $77,000,000 valuation of the P.T.C. was difficult to reconcile with the approximate $85,000,000 valuation agreed to by the P.U.C. in the reorganization proceedings. The court held that the depressed market value of the securities of the P.T.C. should not have ruling weight in the determination of base; that cost of new equipment deliverable in 1942 was a valid part of the rate base; that an adequate amount of working capital should be allowed in base; that a capitalization of paving costs should be included in the rate base; that costs should reflect current prices of labor and materials; that under certain circumstances reproduction cost should be an important element in fair value; and that the amount of depreciation determined by the P.U.C. was excessive.

The court also felt that the attitude that the urban transit business was a "dying art" should not result in a depressed valuation of the base, for "dealing inadequately with the appellant will strengthen the forces of dissolution." The court expressed this philosophy:

> "The important fact is that the appellant is performing an indispensable service in Philadelphia. So long as that service is essential and cannot be replaced, the interests of the public would seem to indicate the wisdom of allowing a reasonable return on a fair valuation to perpetuate the service rather than to hasten its end. Such treatment should supply the company with an incentive rather than to hasten its end. Such treatment should supply the company with an incentive to continue to modernize the system and to provide facilities in the future meeting the demand, by conforming with new methods of transportation as they are developed." [29]

Rate of Return. The 1944 decision of the Superior Court of Pennsylvania maintained that a 6½% return on the Court's $93,000,000 base constituted a "fair return." This decision overruled the 6% allowed the P.T.C. by the Pennsylvania Public Utilities Commission. In past years this 6½% return would have been regarded as inadequate by the Commission and the courts.[30] The ability of urban transportation companies to earn a 6½% return has been greatly reduced by the rising cost structure of the industry in the face of a continuous traffic decline. The court, in allowing the P.T.C. a 6½% rate of return, said:

> ". . . the rate of return is a matter of public and consumer interest . . . to insure in good times and bad, the ability of a public utility to serve the public, to have sufficient credit and cash to enable it to fulfill those duties." [31]

Each utility presents a different problem. The electric and gas utilities have much less risk and uncertainty connected with their business, and their rate of return need not be the same as for those utilities with which the P.T.C. is classed. The rate of return, the court added,

> ". . . should be reasonably sufficient to assure confidence in the financial soundness of the utility and should be adequate, under efficient and economical management,[32] to maintain and

[27] P.U.C. Reports, Vol. 24, pp. 95-96, 101-124. This was $8,000,000 less than the base in the reorganization proceedings.

[28] 155 Pa. Superior Court Reports 9 (1944). The Supreme Court of Pennsylvania in a *per curiam* decision of September 27, 1944, refused to accept an appeal of the Superior Court's decision. (See 350 Pa. 373.)

[29] **Ibid.**, p. 18. The court allowed a total valuation of $86,951,000 plus $3,325,093, equipment deliverable in 1942, a total of $1,700,000 additional working capital, and a $4,349,000 franchise paving cost.

[30] See: Buckwalter, W. Roy, "The Rate of Return on Pennsylvania Utilities," **University of Pennsylvania Law Review**, Vol. 91, No. 7, April 1943.

[31] 155 Pa. Superior Court 9, 28.

[32] In a 1949 proceeding before the P.U.C. of Pennsylvania (Frederick A. Myers v. Pa. P.U.C., P.T.C. Interviewer) the contention was raised that the P.T.C. management was mismanaging its financial affairs in granting a wage increase to its employees. The P.U.C. dismissed the complaint on the ground that it was without power to annul wage increases or decreases or dismiss officials responsible for it. It was held that the Commission is not "the financial manager of the utility and it is not a super board of directors for a public utility; its sole power is to see that in the matter of rates, service, and facilities the treatment of the public by public utility companies is fair." (Docket No. 14359 relating to February 1948 wage increase; 65A 2d 256.)

support its credit and enable it to raise the money necessary for the proper discharge of its duties."[33]

In November 1951 the P.U.C. refused to satisfy a complaint of the City of Philadelphia to set aside the rate increase which became effective on February, 1951.[34] The P.U.C. contended that the fare of February 1951 would produce only $4,620,500 and that this sum was below the 6½% rate of return on a valuation of $93,000,000 allowed by the Superior Court in 1944.

Even under the rate schedule filed by the P.T.C. on February 29, 1952, the company will not earn the 6½% fair return, since the estimated yield from this rate increase totals $5,172,000. This amount, less estimated income taxes of $2,407,000 will enable the company to earn a "rate-case basis" toward fair return of approximately $4,467,000 annually. This return would be approximately $1,578,000 less than the estimated amount the company is entitled to earn under the P.U.C. order of November 19, 1951.[35]

Rate Level. The essence of the power of the Public Utility Commission of Pennsylvania is to determine the rate charged. This Commission has approved rate increases six times since 1920 as indicated in Table 10. The transit fare in Philadelphia had been five cents from 1885 to 1920. This fare had become a political fetish, and was departed from only with the greatest of difficulty.

TABLE 10

Rate Increases of the P.R.T.-P.T.C., 1920-1951

Year	Basic Fare
1920.....	7¢, 4 for 25¢
1924.....	8¢, 2 for 15¢; 10¢ bus
1947.....	10¢, 4 for 35¢; 10¢ bus
1948.....	10¢, 13¢ bus, 2 for 25¢
1950.....	12¢, 4 for 45¢; 3¢ extra transfer
1951.....	15¢, 3 for 40¢; 1¢ for free transfer to two subsequent vehicles
1952[1].....	15¢, 3 for 45¢; 3¢ exchange and no transfer

Source: Tariff schedule filed with Pennsylvania P.U.C.

[1]Proposed February 29, 1952.

All of these rate increases met with the bitter opposition of the City of Philadelphia, and all but the 1951 increase were subjected to prolonged suspension by the Public Utilities Commission of Pennsylvania under the Public Utility Law of 1937.[36]

It is, of course, the duty of the city and the P.U.C. to examine with extreme care any petition of the P.T.C. for a rate increase. These agencies would be recreant to their duties if they did otherwise. But the attacks on the petitions for rate increase should have valid economics as a basis and not partisan politics. For too long a time the P.T.C. has been made a political football, a "whipping boy." Its rate petitions have been subjected to arguments based upon half-truths or upon basic misrepresentation of the facts.

Seldom have attacks upon a P.T.C. rate petition been as vitriolic as those of the city in the 1952 rate proceedings. The incumbent Mayor of Philadelphia on February 29, 1952, went so far as to propose the following program: (1) to refuse the permission of the city to the

[33]**Ibid.**

[34]Complaint Docket No. 15127, City of Philadelphia v. P.T.C., decided November 19, 1951.

[35]Philadelphia v. P.T.C., C.D. 15127. About $2,527,000 of the $4,467,000 would be used to pay interest and other debt charges. (See: Statement of the P.T.C. filed with the P.U.C. on February 29, 1952.) On March 24, 1952 the Public Utilities Commission of Pennsylvania suspended the proposed rate increase of the P.T.C. for six months, until October the first. An additional extension of three months is permissible under the Public Utilities Law of 1937.

In the 1948-49 rate proceedings the P.U.C. granted an interim rate increase because of increased wage costs sustained by the P.T.C. as a result of its contract with the union of February 11, 1949. The Superior Court, however, on June 10, 1949, granted a writ of *super sedeas* from the order of the P.U.C. and set the interim rate increase aside on the ground that it had granted an interim rate increase of $6,601,000 whereas the proved increased labor costs were only $2,420,000.

[36]Laws of Pa., 1937, p.l. 1053, Sections 301, 308 (b).

TABLE 11

Number of Passengers, and Rides Per Capita, of P.T.C., Selected Years, 1910-1951

Year	Number of Passengers (Millions)	Rides per Capita
1910	443	286
1915	594	352
1920	908	498
1925	927	491
1930	880	451
1932	687	349
1934	650	334
1936	685	353
1938	637	329
1940	672	348
1941	744	383
1942	950	485
1943	1,116	567
1944	1,092	551
1945	1,106	555
1946	1,119	557
1947	1,078	534
1948	1,035	510
1949	914	447
1950	827	N.A.
1951	790	N.A.

Source: Chamber of Commerce, **Philadelphia Facts** 1950, p. 44.

rate increase, citing the 1907 agreement;[37] (2) to terminate the lease of the P.T.C. on the city-owned transit system; (3) to operate buses by the city in competition with the P.T.C.; (4) to require the P.T.C. to pave from curb-to-curb; and (5) to increase bus license fees. This program is so destructive in nature that it is difficult to take it seriously. Yet it indicates the length to which political considerations may drive the city in its opposition to rate increases. It would, in effect, usurp the rate-making function of the P.U.C. and would, if successful, drive the P.T.C. into receivership, and force the issue of municipal ownership.[38]

It is true that there has been a substantial decrease in the number of passengers riding the transit system of the P.T.C. (See Table II.) This decline, however, is a long-run trend characteristic of the urban transportation industry in the United States and is due to the factors discussed in the early part of this paper.[39] The urban transportation industry nevertheless has a high degree of inelasticity of riders as far as total receipts are concerned. This inelasticity is much greater in the case of the long-haul rider. He is more or less a "captive" rider and cannot, therefore, readily shift to other means of transportation on a long-run basis. The short-haul rider group is characterized by a much higher degree of elasticity in the face of rate increases. But in consideration the loss of rider patronage the overall loss is the most important consideration insofar as it influences total revenue. A rate increase will decrease passenger travel but not to the extent of offsetting the increased revenue from the fares of the continued level of passengers. In 1946 the passenger revenue of the P.T.C. was

[37]The 1907 agreement of the city and the P.R.T. provided that city consent was needed for a rate increase, but this power has been superseded by the Public Service Act of 1913, and the replacement Public Utilities Law of 1937 which gave rate-making power to the Commission. This power of the P.U.C. to supersede the city in rate petitions of the P.T.C. has been sustained in the courts. (See: Phila. v. P.S.C. 83 Pa. Super. Ct. 8 (1924); Phila. v. P.R.T., 27 Fed. (2d) 439 (1926); Sawbor v. P.R.T., 27 Fed. (2d) 406 (1928). Also see: Scranton v. P.S.C. 268 Pa. 192 (1920) and Phila. v. P.R.T. 224 Pa. 545 (1909), Phila. v. P.R.T., 228 Pa. 325 (1910)).

The city has even contended that any rate change of city-owned facilities would violate section 10, Article I of the Federal Constitution forbidding the impairment of contract, and also Section 17, Article I of the Pennsylvania Constitution of 1874.

[38]The city can buy the P.T.C. by giving a six-months' notice before July 1st of any year. The city must pay the full par value of the preferred and common stocks, plus a payment to the stockholders of any surplus, and also assume the indebtedness of the system. The present Mayor has asserted that the city will never purchase the P.T.C. while he is in office. At present approximately 85% of all fares are received in P.T.C. owned lines, 10% on the Broad Street Subway, 3.2% on the Frankford Elevated, and 0.7% on Route 59 (Bustleton).

[39]For example, the Saturday riding via P.T.C. had declined substantially when compared with Monday to Friday travel. Comparison for the years 1942-1951 follow (Monday to Friday=100): 1942, 97.2%; 1943, 103.7%; 1944, 102.3%; 1945, 99.3%; 1946, 91%; 1947, 85.7%; 1948, 84.1%; 1949, 81.9%; 1950, 79.3%; 1951, 76.8 percent. Amusement tax receipts have declined 27.5% in Philadelphia since 1949. Auto registration in Philadelphia has increased every year since 1945. On January 31, 1952, there were 375,288 automobile registrations in Philadelphia, as compared with 215,000 in 1945.

TABLE 12
Comparison of Fares in 25 Selected Cities, 1940 and 1952

City	Present Operator	Fare 1952	Fare 1940
New York	Board of Transportation	10¢	5¢
Chicago	Chicago Transit Authority	18¢-17¢	10¢-7¢
Philadelphia	Philadelphia Transportation Company	15¢	8¢-10¢
Los Angeles	Los Angeles Transit Lines	15¢	7¢
Detroit	City of Detroit Dept. of Street Railways	15¢	6¢
Baltimore	Baltimore Transit Company	15¢	10¢
Cleveland	Cleveland Transit System	15¢	10¢
St. Louis	St. Louis Public Service Co.	17¢	10¢
Washington	Capital Transit Company	15¢	10¢
Boston	Metropolitan Transit Authority, Mass.	15¢-10¢	10¢
San Francisco	Municipal Railway of San Francisco, Calif.	10¢	5¢
Pittsburgh	Pittsburgh Railways Company	17¢-23¢	10¢-15¢
Milwaukee	Milwaukee Elec. Railway and Transport Co.	15¢	10¢
Houston	Houston Transit Company	15¢	10¢
Buffalo	Niagara Frontier Transit System, Inc.	15¢	10¢
New Orleans	New Orleans Public Service, Inc.	7¢	7¢
Minneapolis	Twin City Rapid Transit Co. (also operating in St. Paul)	15¢	10¢
Cincinnati	Cincinnati Street Railway Co.	16¢	10¢
Seattle	Seattle Transit System, Washington	15¢	10¢
Kansas City	Kansas City Public Service Co.	20¢	10¢
Newark	Public Service Coordinated Transport, New Jersey (operating in 375 communities in state)	10¢	5¢
Dallas	Dallas Railway and Terminal Company	15¢	7¢
Indianapolis	Indianapolis Railways	15¢	7¢
Denver	Denver Tramway Corporation	12¢	10¢
San Antonio	San Antonio Transit Company	10¢	10¢

Source: **New York Times,** March 6, 1952, p. 22.

approximately $57,230,000 and in 1951 it had increased to approximately $71,206,000 in spite of six rate increases.[40] The fare in Philadelphia has followed the upward trend of every major city since 1940. (See Table 12.) Urban transportation is not exempt from the law of inflation, and it cannot operate on faith and good-will alone. It must have profits to survive.[41] The alternatives to a self-sustaining urban transportation in Philadelphia are: (1) reduction of service and reduction of employee level, (2) postponement or abandonment of new equipment purchases, (3) special tax treatment, (4) reduction of rentals to the city,

[40]Philadelphia Transportation Co., **op. cit., 1946,** and **1951.**

[41]Profits and loss since 1945 for the P.T.C. (before income tax adjustments) are:

Year	Profits	Loss
1945	$3,346,255	.....
1946	1,234,924	.....
1947	1,140,636	.....
1948	506,587	.....
1949	.....	$2,265,164
1950	.....	317,541
1951	1,847,872	.....
1952	.....	250,000[1]

Source: Philadelphia Transportation Co., **op. cit.**

[1]Estimated annual rate. This loss is expected to continue until rate relief is granted.

(5) full-rate for school children,[42], (6) reduction of wages on the principle of inability to pay, (7) abandonment of unprofitable routes, (8) adoption of zone rate principle, (9) receivership and reorganization, or (10) municipal ownership. All of these alternatives, or a combination of them are a poor substitute for adequate rates for adequate service.

SUMMARY AND CONCLUSION

The entire urban transportation industry is plagued with the problem of steadily increasing costs and a continuous decline in passengers. The trend of these costs, particularly taxes, materials, and labor, are headed still further upward. Until stability is attained in the costs of rendering urban transportation service there can be no real hope of maintaining stability in rates.

A realistic approach must be adopted toward the problems of urban transportation in Philadelphia by the city authorities. Alternatives to rate increases must also become a predominant consideration and labor and management must cooperate to the fullest extent possible in seeking them. This must be a **bona fide**, two-way program of cooperation predicated on the assumption that a solution can be developed. Labor should be concerned with the possibility of increased productivity on its part, whether it be in the direction of the elimination of nonproductive labor or the elimination of nonproductive routes and facilities. Management must be concerned with a maximum improvement of economic and social benefits to the workers within the framework of an efficient urban transportation system. This labor-management cooperation will result in a higher degree of efficiency and productivity, and will, in the last analysis result in decreased costs of operation.

Such program is desirable in that, in the long-run, it may remove the need for rate increases, and it must be borne in mind that, at some future point, the rate may reach a level where further increases will be beyond the ability of the traffic to bear it. Even so, long and expensive delays in granting at least a semi-compensatory rate should be avoided. The Philadelphia Transportation Company, like all public utilities, is a public servant and should be treated as such. Otherwise the dilemma of the Philadelphia Transportation Company will become the dilemma of the City of Philadelphia.

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[42]Since 1947 the school children of Philadelphia have been provided by the P.T.C. with a special 7½¢ school ticket. In 1948 the daily use of these tickets was 67,000 and in 1951 it had risen to 96,000 daily. In 1952 this school ticket sale will approximate 16,000,000 a year. The P.T.C. is, therefore, underwriting a large portion of the cost of the transportation of school children. This is highly desirable, but it represents a "social-cost" assumed by the P.T.C. It is reasonable to assume that it should be compensated for this by the other elements of its rate structure.

Ethics in Business

by MYRON S. HEIDINGSFIELD*

A subject which is drawing increasing attention in the present is the standard of ethics which characterizes behavior in business and government. This article suggests that business management must take the lead in the development of ethical standards if the economy is to successfully lead the world in its economic growth in this present day.

THE ever-increasing productivity of American enterprise, with the resultant increase in standard of living, is an American phenomenon regarded with amazement and respect by all members of the world community. This rapid growth in productivity has accelerated, rather than impeded, the acceptance of ethical practices by many of our leading business organizations. However, on noteworthy occasions this concept has been shunted aside for the more questionable aim of a quick profit, and it is this latter circumstance which has resulted in unfavorable publicity. Despite the fact that unethical practices are infrequently encountered, their even occasional occurrence is something that all right-thinking business men strive to eliminate.

The growth of the corporate structure with its material strength has become one of the most important factors in our economy. As a result, the men who control or guide these organizations exert very important influences on the economic and social well-being of this nation. Their responsibilities, therefore, have become more significant. It is their problem not only to run business on an economically sound basis, but to accept, as well, the social responsibility imposed by a position of eminence.

> "In the eyes of some impatient critics the very strength of our society is a weakness. We are in truth a society composed of millions of centers of initiative. Almost every citizen, and literally every business man, day after day, makes decisions which shape our society. It is not planned neatly and completely at the top; its planning is done at all levels from bottom upwards. A complex system and one difficult to understand, but it works. And it has given us something that few people have ever had — freedom of opportunity. And, in turn, this freedom of opportunity is our greatest potential asset in the conflict with the totalitarians. This means that the leadership of our society as a whole can be continuously reinforced and revitalized by recruits from all segments of our population. Providing places for talent thus developed requires a dynamic, risk-taking, and venturesome setting. No rigidly limited and confined party membership narrowly defines the source from which our leadership may come. No single center of initiative controls our destiny." [1]

If each businessman is forced to make decisions which ultimately shape our society, then it is important that he realize that his functions include not only those associated with the profitable management of business, but also those related to the formulation of decisions which shape the moral values of the economy as well, and which latter decisions must be molded by ethical concepts. This is a personal responsibility, since, in reality, no person can force another to act from ethical motivation.

> "Business reflects pretty well the spirit of the community in which it exists. It has been moulded by popular sentiment. John Dewey remarked in his **Human Nature and Conduct**: 'If the standard of morals is low it is because the education given by the

*Myron S. Heidingsfield is the Professor of Marketing in the Temple University School of Business and Public Administration. He is a practicing market research consultant and is the co-author of two texts and the author of several professional papers on marketing problems.

[1] Merrill, Harwood F., ed., **Responsibilities of Business Leadership**, Harvard University Press, Cambridge, 1948, p. XIII.

interaction of the individual with his social environment is defective.'"[2]

"Surely it is from the natural and necessary relationships of social life that any and every ethical system arises. If it were not for those relationships there would be no moral philosophy; for the moral philosopher (unlike some modern economists) cannot philosophize in a vacuum. What gets him going and makes him useful is the fact that these relationships give rise to problems; problems of will and purpose, not merely of arithmetic."[3]

DEFINITION

The word "ethics" comes from the Greek word meaning "custom." Today it has come to be associated with the philosophy which attempts to determine the difference between right annd wrong. Unlike morals, which are normally negative, telling us what not to do, ethics is the basis for a positive philosophy which helps to guide our decision-making in a variety of circumstances.

As can be seen, ethics is not concerned with the punishment of individuals who do wrong. An ethical man does not seek to justify his actions by pleading the fact that he has kept within the law. It has sometimes been said that ethics means "what should be," and that it carries with it a feeling of the "oughtness" of things.

Repeatedly it has been said that the Golden Rule and the Ten Commandments are, in reality, a summation of the ethical principles which control a society such as ours. Ethics, however, cannot be summed up as a body of rules applying empirically to every situation. Ethics has evolved from lessons of the past. In a sense it represents the total of the aims and consequences of previous actions, but has never solidified itself into an inflexible pattern which does not take cognizance of the changing mores of society.

Instead of blindly and unconsciously adopting what seems to be good ethical practice, businessmen should take a positive stand. Each policy, each action, should be considered in the light of its ethical value. There would be a lesser problem today in the government or in business if management had realized this need for an active and positive approach to ethics as it is applied to each day's operation. In considering this approach, business management must realize that ethics is a two-way street. The ethics of the individual and of the group must be integrated with the ethical standards of the whole community. Higher standards become rules for conduct only when they have been accepted and put to use by the individuals who make up that society.

One of the reasons why there is no positive approach to ethics is that normally no prominence is given to this moral philosophy in the educational system.

"There was a time, not so long ago, when the systematic study of ethics and jurisprudence occupied a prominent place in colleges and law schools; but the law schools became vocational institutions, cramming cases, and the late-nineteenth-century economists disposed of ethics by proving to their own satisfaction that we don't need any—the preface to J. B. Clark's **Distribution of Wealth** is the classic example. Now that we find we do—and that after all there is a case and a need for the moral evaluation of social policies and institutions—we find ourselves very poorly equipped for the job, short of both tools and technique."[4]

THE PROBLEM

The perennial question posed is, "What are ethics in business"? This question has harassed every right-thinking businessman and statesman since time immemorial. Is ethical practice merely a matter of telling the truth? Is it merely knowing what is right or wrong in terms of some accepted code of practice? Or is it merely the presentation of facts without interpretation or personal comment?

Obviously, ethics cannot be defined by answering any single question. Ethics

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[2]The Royal Bank of Canada Monthly Letter, "Ethics in Business," Montreal, March, 1948, p. 1.

[3]Orton, William A., **Fortune**, "Business and Ethics," October, 1948, p. 118.

[4]**Ibid.**, p. 119.

seems to incorporate the answers to all of these questions, and yet it is so intertwined with personal emotions or sensitivity to other people's feelings that it is often overlooked or by-passed in order to avoid unpleasantness.

This attitude is often embodied in a set of stereotyped phrases which frequently characterize business dealings of something less than good ethics. How often has it been said:

"It's all right—it's legal."
"What's the difference? Nobody will be hurt."
"Who will know, if we don't tell them?"
"Everybody's doing it, why shouldn't we?"
"Let's charge what the traffic will bear!"
"If you want to do business with me, you'll have to play it my way!"
"Let the buyer beware!"
"Always look at the fine print!"
"One hand washes the other!"
"It's the survival of the fittest!"
"When you're in Rome . . . !"

What does all this mean? It may be said that some of our business practices are characterized by deliberately misleading statements, exaggerated advertising claims, fear selling, reciprocal buying, rebates, the maintenance of two sets of books, price exploitation or collusion, oversized containers with undersized contents, trickily or ambiguously worded contracts, tie-in sales, and the like. These indicate in a negative way what the problem may be and what may be meant by ethical practice. It would seem that a much more positive stand should be taken.

WHAT CAN BE DONE

It would be presumptuous on the part of the writer to set up a series of rules on what should be done. However, there are techniques, which, if properly utilized, may lessen the problem immediately and make it an anachronism in the future.

The most pliable group with which we have to work are children. Normally they have not been subjected to the rigors of business dealings and may not have acquired either a taste for or familiarity with the unethical practices which are considered appropriate by a minority of people. Therefore, it behooves parents to indoctrinate (this word is used advisedly) their children in the ethical practices that are currently accepted by our society. Moreover, it means that parents themselves must avoid or eliminate any habitual practices which may be considered unethical. Children are quick to sense the distinction between a lecture and honest practice, and it would be unwise as well as unethical for parents to practice this form of hypocrisy before their children. The teachers in this country have traditionally been the whipping boys for the deficiencies of parents, many of whom maintain that it is the responsibility of the teacher to train children in ethical understanding and action. How can this be done if the parents are negligent of their responsibility, and yet, by the same token, have almost complete control over the youngster's life and training until he reaches school age? The first five years of life are the most formative, and during these years it is the parents who must accept this responsibility, not the teachers. However, teachers can and should buttress parental training by making ethical practice a living thing through teaching, through stories, and through personal example within the classroom. A teacher who is unfair, who gives vent to her emotions, who discriminates, and the like, is acting in an unethical way, and may break down the previous constructive training by the parent.

These considerations do not excuse the businessman from responsibility. Most people spend more of their adult lives in business than in any other activity. Up to the present the ethical approach has been relegated to the unspoken, the unemphasized. It is the responsibility of the businessman, through individual action and through corporate policy, to make ethics live. Ethical practice must

become as important a motivating force as increasing productivity, decreasing cost, increasing net profit. There is no excuse for any other form of action.

CONCLUSIONS

Admittedly, the concept of ethical practice is difficult to grasp in its entirety, but it is the writer's belief that if it is not finally understood and made an integral part of everyday living, whether in business or otherwise, the ideals for which we have fought two world wars may be doomed. Unethical practice, even by the few, normally results in group regulation, the theory being that if we cannot conduct ourselves ethically and govern our businesses accordingly, the government, not necessary representative of our beliefs, may be forced to further implement its controls over the socio-economic structure.

Business leadership is a public trust. Statesmanship must characterize that leadership if we are "to offer a message of courage and hope to all people." [5] By doing this we "can help an economically strong America to lead other nations to a lasting prosperity, freedom, and peace," [6] without a tortured conscience. Because it will be a strength which emanates from the knowledge that we have done right, our success is, and will be, a sound and respected one.

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[5] Merrill, **op. cit.**, p. 12.
[6] **Ibid.**

Railroad Productivity Increases: Who Benefits?

by KENNETH A. MIDDLETON*

Much discussion is currently concerned with the questions whether and to what extent a rise in labor productivity should be accompanied by higher wage rates, whether such wage increases are "inflationary", and so on. Detailed measures of what has actually taken place in response to increases in productivity would be helpful in this connection but have been discouraged by statistical and other difficulties, although much work has been done in recent years in the measurement of productivity changes themselves. This article discusses methods of tracing these effects of productivity change as applied to the railroads. It compares 1921-24 with 1946-49, concluding that railroad labor productivity—in terms of service performed per manhour worked—rose some 120 percent. Concurrently, however, real income of railroad employees, per hour of work, increased only about 56 percent, while the amount of service obtained by the railroads' passengers and freight patrons, per unit of real cost to them, advanced about 82 percent. The article also compares the fortunes of different classes of employees and of passengers versus freight buyers, pointing out that changes in real-income positions are partly due to the differences in movements of prices independent of railroad fares, rates, and wage payments.

THE term "labor productivity" as used here—and the usage is typical of current discussions and measurements on the policy and statistical level—means the average physical productivity of labor: the physical volume of output per man or per manhour. Actually, this quantity has less direct pertinence to wage determination than the familiar marginal productivity concept in economic theory, but the latter is much harder to estimate empirically. In collective bargaining negotiations, the unions are inclined to maintain that real wage rates ought to rise in the same proportion as productivity, in the sense of average productivity. Precisely this contention has been advanced recently in the steel industry case. The much-discussed automatic annual rise of 4 cents per hour, as provided in the General Motors contract which went into effect in 1948, was intended to find justification in the historical rise of productivity in the same sense. Early this year, it was reported that the Wage Stabilization Board was leaning toward a policy of allowing rises in wage rates based on increases in productivity, where average productivity is evidently meant, a policy said to have the approval of the President and his council of Economic Advisers.[1]

On the other hand, it is held by some, with good reason, that rises in productivity should be allowed to reflect mainly in reduced prices to the purchasers of the product. It is in this way, they contend, that the benefits of heightened efficiency are most widely and rapidly disseminated among the population at large. Whatever the rights or wrongs of the question, a methodology of determining what, in fact, has happened or is happening in response to productivity changes would be useful in the formulation of policy, either in the private or public spheres, and in the appraisal of its effectiveness. This paper indicates the difficulties that are encountered in effecting such measurement, and it presents the types of conclusion which such measurements can yield if the railroad industry is used as an example.

The points under study may be made clear by a simple example. If a manufacturer finds this year that 105 units of product are produced per man-hour

*Kenneth A. Middleton is a member of the Statistics Faculty of the Temple University School of Business and Public Administration.

[1]New York Times, January 17, 1952.

of labor, as against 100 last year, his plant has experienced a 5 percent increase in labor productivity, in the popular sense of the term. The cause of the increase may be found in a change to better equipment or methods, better raw materials, a more nearly optimum degree of capacity utilization, or in greater skill and application on the part of his employees. If we assume that the change did not involve a relative increase in time worked by the more highly paid labor in the plant, nor other increases in costs, the wage rate may be raised by 5 percent without raising the selling price. The same profit per unit as was earned in the preceding year should result from each unit sold. Or, on the other hand, if the same level of wages and other costs is retained, a reduction in selling price is possible while still retaining the same profit per unit. The size of this reduction will depend on the importance of costs, other than labor, to output. If the rise in productivity was attained through use of more costly equipment and materials, the indicated adjustments in price or wage rates will be limited, or even prevented, by the rise in materials costs and in depreciation. Finally, if all costs are held constant and the same selling price is also maintained, profits per unit will rise.

In appraising the net results of any of these possible adjustments, one should also have to consider the real-income effects on the persons or groups involved. That is, a rise of 5 percent in the wage rate would not benefit the recipients if the price level of the goods and services bought with their money also rose 5 percent. Moreover, it might prove inexpedient to increase production in the same ratio by which productivity increased. In this event, the volume of employment would be curtailed, thus contributing to "technological unemployment." An assessment of the results of a productivity change should give some attention to this possibility. Presumably, a reduction in the selling price of the product would be the adjustment most likely to render a curtailment of employment unnecessary.

SKETCH OF CURRENT WORK IN THIS FIELD

The measurement of productivity change itself has received considerable attention during the past twenty years, originally motivated chiefly by its connection with the technological unemployment, just referred to. Emphasis has now shifted to its possible relevance to wage negotiations, its bearing on government price and wage policy, its significance as a factor in economic growth, and, lately, its usefulness as a standard for judging industrial efficiency of different countries and areas. Although various excellent empirical studies of the subject have appeared from time to time since the late 19th century, systematic and comprehensive index number computation in this field began in the Thirties with the publication in 1932 of F. C. Mills' **Economic Tendencies in the United States**, which contained productivity indexes for several manufacturing industries. Later a comprehensive program was begun . . . under the National Research Project of the Works Progress Administration. Issuance of statistical and other information has been continued during the last ten years, with steady improvements in coverage and detail, by the Productivity and Technological Developments Division of the United States Bureau of Labor Statistics. In addition to its other functions, this division now works with the Technical Assistance Division of the Economic Cooperation Administration in a program which provides, among other things, for international dissemination of detailed information on productivity in the United States, for more than a hundred individual products. Studies for some of these products have already appeared, products as diverse as gray iron castings and men's dress shirts.[2] Important studies and statistical series on the subject of productivity have

[2]Economic Cooperation Administration, Technical Assistance Division, in Cooperation with the U.S. Department of Labor, Bureau of Labor Statistics: "Case Study Data on Productivity and Factory Performance"; "Gray Iron Foundries," (August, 1951); "Men's Dress Shirts," (August, 1951).

been issued by other government agencies and by nongovernment groups and individuals, notably the National Bureau of Economic Research.[3]

The empirical and statistical determination of the economic consequences of changes in productivity, as distinct from the measurement of the changes themselves, has received no such wide application, partly because of the theoretical and statistical difficulties which it presents. In this area, nevertheless, Professor Frederick C. Mills of Columbia University has done notable work in the development and application of a methodology of tracing the economic changes associated with changes in productivity, that is, the "incidence" of productivity.[4] The present article undertakes to adapt the methods suggested by Professor Mills to the railroads, where they have not, to the writer's knowledge, been applied before; these methods yield results in terms of index numbers. An effort has also been made here to present, in absolute dollar amounts, the impact of productivity change and the extent to which it was applied toward adjustment of prices, wage rates, and other variables.

MEASUREMENT OF RAILROAD PRODUCTIVITY

In measuring the incidence of productivity, the first requirement is a measurement of the change in productivity itself. For this purpose two periods, 1921-24 and 1946-49, have been selected for comparison. Each of these periods represents a business cycle as determined by the National Bureau of Economic Research. By averaging data for an entire cycle, differences in the phase of the cycle are prevented from affecting the results. It would be misleading, for example, to compare a year of prosperity with a year of depression because this would tend to confuse changes due to a mere increase in the degree of capacity utilization with those resulting from long-run technological and organizational improvements. Moreover, the present purpose is to concentrate on the latter. The two cycles were chosen as far apart as the availability of comparable data would permit, while also avoiding years during which this country was at war. In this way, it was believed that the data would provide an interesting historical summary and also that, since the changes would presumably be large over so long a period, they would tend to stand out more clearly amid errors unavoidable in statistical estimation.

It was thought necessary to assure that the change in productivity was not predominantly due to the difference in average load per car. Computations were based on the average size of freight cars and passenger cars used during these two periods and the traffic carried per car-mile. These computations indicated that in 1946-49 the loaded freight cars were carrying, on the average, 58 percent of their capacity as compared with about 57 percent in 1921-24; and that 17 percent of available seating capacity of passenger cars was, on the average, being used in the later period, as compared with about 16 percent in the earlier. From these figures it was judged that mere fuller loading of cars could not have affected productivity measures greatly. Consequently, whatever change is shown in productivity must be due primarily to shifts in methods, equipment, and organization.

The statistical investigation is necessarily confined to the Class I steam line-haul railroads because of the need for a variety of comparable data, but this is

[3]The National Bureau's studies in which productivity changes have been measured and explored are numerous and include agriculture, manufacturing, mining, and transportation. As entirely random examples of other studies in the field, the following may be cited: Bell, Spurgeon, **Productivity, Wages, and National Income,** Brookings Institution, Washington, D. C., 1940; Hogan, William, **Productivity in the Blast-Furnace and Open-Hearth Segments of the Steel Industry 1920-46,** Fordham University Press, New York, 1950.

[4]Mills, F. C., "Industrial Productivity and Prices," **Journal of the American Statistical Association,** June, 1937; **Prices in Recession and Recovery,** (final chapter), National Bureau of Economic Research, New York, 1936; "Technological Gains and Their Uses," **Science,** February 28, 1947; "The Role of Productivity in Economic Growth," a paper delivered at the 111th annual meeting of the American Statistical Association, Boston, December 28, 1951.

not a very serious restriction. These railroads have annual revenue ordinarily in excess of a million dollars and engage primarily in inter-city transportation rather than switching and terminal operations. The term "steam" serves merely to exclude wholly electrified interurban systems without excluding the electrified or dieselized service of railroads which traditionally depended in the main on steam motive power. The railroads included in the study thus account for upwards of 95 percent of operated mileage, equipment, traffic, employment, and revenue of all steam railways.[5] If the relative importance of the specified railroads had changed radically over the period, or if they had yielded much of their function to switching and terminal companies, express companies, or the Pullman Company, productivity measures confined to the Class I roads might be vitiated; but available information indicates that inclusion of other railroads and associated services would not have affected the results materially.

The actual measurement of productivity is based on dividing a measure of the total output of service by the number of manhours worked in each of the two periods. The measure of output consists of revenue freight-ton-miles and revenue passenger-miles, each being weighted by average revenue per ton-mile and per passenger-mile, respectively, in 1921-24. The measure of manhours worked excludes what the I.C.C. calls "time paid for but not worked"—hours that arise where the real determinant of pay is the length of run but is converted to hours by rather fictitious ratios that do not yield the actual running time. "Constructive allowances" are also excluded in order to yield a figure as close as possible to the amount of time actually spent on the job by railroad employees. This procedure, summarized in Table 1, is quite a conventional method of measuring railroad labor productivity, having been applied with slight variations, by the Bureau of Labor Statistics, by Hultgren and by Barger.[6] Insofar as these other measures include years being measured, it was possible to obtain series for comparison with those developed here. Against an index of 220.7 resulting from this work, the Bureau of Labor Statistics data would yield 215.0 for comparable periods; Barger would give 219.8. The measures are not identical because the weights are chosen for different years; there are also slight differences in the definition of hours worked. The Bureau of Labor Statistics, for example, excludes the hours of supervisory and executive employees; index number formulas differ slightly; and Barger includes the Pullman Company. Extensions of Hultgren's measure to include the time periods selected here were not available.

There are many theoretical shortcomings in this kind of measurement. The answer which is being sought is: by how much has the number of man-hours required to accomplish each of the various tasks of the railroads declined and what is the aggregate effect of these changes on current operations? To the extent that the different services performed by the railroads have changed in nature and in proportion to one another the measures described above are faulty. The precise measurement of what is sought would involve knowing just how many manhours might be allotted, for example, to a shipment of oranges from California to Philadelphia on a particular route, and similar information for all the multiplicity of different kinds of shipments and passenger trips offered by the rail-

[5]Unless otherwise indicated, the statistical basis of statements and computations in this paper is **Statistics of Railways in the United States,** U. S. Interstate Commerce Commission, (annual).

[6]Dunlap, W. H., "Productivity of Railroad Labor," **Monthly Labor Review,** March, 1927, p. 1; Bowden, Witt, "Productivity, Hours, and Compensation of Railroad Labor, 1933 to 1936," U. S. Bureau of Labor Statistics, **Monthly Labor Review,** July, 1937; the present writer's article in the same publication, September, 1943; Hultgren, Thor, **American Transportation in Prosperity and Depression,** National Bureau of Economic Research, New York, 1948; Barger, Harold, **The Transportation Industries, 1889-1946,** National Bureau of Economic Research, New York, 1951, supplemented by unpublished extensions made available by courtesy of Professor Mills; U. S. Department of Labor, **Handbook of Labor Statistics,** 1950 edition.

TABLE 1

Railroad Labor Productivity, 1946-49 (1921-24 = 100)

	1946-49 as a Percent of 1921-24
Revenue Freight, ton-miles..	168.41
Revenue Passenger-miles ...	124.41
Combined Traffic, weighted..	159.27
Man-hours Worked	72.15
Productivity:	
Output per Man-hour	220.7

roads. Such data would involve charging, by some almost inconceivably complicated cost-accounting system, man-hours in maintenance and office work, as well as in train operation, to particular shipments and passenger trips. Once these manhour-requirement data were known for a base period, an index of productivity for the present purpose could be obtained by multiplying the mileages of the various freight shipments and passenger trips in 1946-49 by the manhours per mile as determined from the accounting system for the base years 1921-24, and then dividing this aggregate by the total manhours worked during 1946-49. In conventional index-number notation, where **q** represents mileages of different types of shipments and passenger trips, and **r** represents the labor requirements per mile for each type, the procedure just described could be expressed as follows: $\frac{\Sigma\ q_1\ r_1}{\Sigma\ q_1\ r_0}$

The numerator of this expression represents the manhours that the railroads would have required to do their work in 1946-49 if the 1921-24 level of efficiency had still prevailed. The denominator is simply the total number of manhours worked in 1946-49. Therefore, this formula would be a good indicator of the benefit, in terms of the saving of labor-time, secured by the railroads between the two periods. One is forced to use a measure of output divided by a manhours index, but the same formula as that shown above could be obtained by this method if the proper measure of output were available. It may easily be shown that this formula results by dividing an output index by a manhours index, provided the output index is weighted by unit labor requirements for each kind of output in the base period.[7] Although the base-year value (or unit-revenue) weights would be a rough approximation, these figures except as between passenger and freight traffic are not available. There is reason to believe that the value weights would produce a measure perhaps 10 percent higher than the unweighted index.[8] Although value, or unit-revenue, weights are probably not proportional to man-hour requirements for the various commodities and for passenger service, they are probably closer to the objective than are no weights at all. Consequently, one may well suppose that the measure presented here is also higher than the ideal, but it is difficult to estimate by how much.

Bearing in mind this possibility of an upward bias, the findings in Table 1 may be interpreted as follows: the railroads would, in 1946-49, have required more than twice as many man-hours as were actually utilized to do the work of those years, had the labor requirement for the performance of each of the various transportation services remained at the 1921-24 level. As has already been suggested, such other railroad productivity measures as may be related to these same two periods give a closely similar conclusion.

MEASURING PRODUCTIVITY INCIDENCE

Having concluded that railroad productivity more than doubled between the two periods under consideration, one may now determine the repercussions on pay rates, fares, and the like. In the first place, the results on the real rewards which the railroad organization as a whole received for its services will be

[7] Evans, W. D., and Siegel, I. H., "The Meaning of Productivity Indexes," **Journal of the American Statistical Association**, March, 1942.

[8] Gould, J., Appendix C to Barger, **op. cit.**, pp. 191-213.

TABLE 2

Real Rewards Per Hour Worked: Railroads and Their Employees, 1946-49 (1921-24 = 100)

	1946-49 as a Percent of 1921-24
Total real income of railroads per hour worked	159.0
Real income per hour worked:	
All employees	156.4
Class I (executives, officials, staff assistants)	109.0
Class II Daily-basis (mainly supervisors, investigators)	141.1
Class II Hourly basis (mainly lower-paid, white-collar)	158.0
All others (majority of operation and maintenance employees)	157.6

examined. The total revenue for transportation service, both passenger and freight in 1946-49 was 152.12 percent of that for the base period. The change in the total volume of service rendered was presented in Table 1. The combination of these two facts shows that revenue per unit of service declined in the later period to 95.51 percent of that for the base period. However, far fewer hours were required to produce a unit of service in the later period, and the revenue of the railroads per hour worked by railroad personnel was actually 210.8 percent of the 1921-24 base. The purchasing power of the money received by the railroads for their services may be measured by means of the consumer price index which in 1946-49 stood at 132.68 percent of its 1921-24 level. Through the use of this measurement, it may be concluded that the real reward of the railroads per hour of work performed was 59 percent higher in 1946-49 than in the earlier period.

It is pertinent to compare this purchasing power with that of the employees as a group since this comparison will show something about the extent to which the employees' share of railroad revenue kept pace with the total. It is also of interest to observe the rather sharp differences in the effects on different classes of employees. Such comparisons are presented in Table 2. In general, it may be said that the real income of employees, per hour worked, rose in about the same proportion as the purchasing power of all revenue going to the railroads, but that the nonsupervisory employees, in general, received a much greater relative increase. Nothing is here presented to show whether there are any corresponding differences in the contributions to heightened efficiency by the different groups of employees.

The extent to which the reduction in aggregate hours of work was effected by a reduction in employment or by a reduction in working time for each employee is also significant. The total hours worked on the railroads in 1921-24 averaged 4.4 billion per year. In 1946-49, the corresponding figure was 3.2 billion hours. The problem is to determine to what extent the reduction was brought about through reducing the number of people working and to what extent by shortening the hours of the employees retained. If the average annual hours of 1921-24 had been worked by the 1946-49 employees, the total annual hours would have amounted to 3.4 billion. The difference between this figure and the aggregate for the base period may be deemed to be a result of reducing the number of employees. The number of actual hours worked in 1946-49, given above, was less by 178.5 million, than 3.4 billion, and this difference may be taken to have been brought about by reducing the hours worked by the employees still on the payroll. From this point of view, we may say that the total hours actually worked on the railroads were reduced by 27.85 percent during the

twenty-five year period. Of this amount, 23.83 percent was due to reduction in the number of employees, the remaining 4.02 percent was due to reduction of the average annual hours worked per employee. Since an eight-hour day was already in effect during the earlier period, it is not surprising that a relatively small part of the reduction in aggregate hours worked was accomplished by reducing the working time per employee.

Next, the real gains, if any, to patrons of the railroads should be determined. It has just been demonstrated that, accompanying a doubling of productivity on the railroads, the companies and employees gained something like 60 percent in terms of real income per hour of work. This would lead to the assumption that some other groups, presumably the customers of the railroads, had also benefited by the increased productivity. Considering the passenger group first, it is possible to measure the total amount of money paid by them to the railroads per unit of service rendered. This proves to have declined in 1946-49 to 72.04 percent of the base period level. This, however, is not a full measure of the benefit of this group inasmuch as their incomes have changed and the amount of work required on their part to earn a given amount of income also has changed. For the purpose of this study, railroad passengers were assumed to be a reasonably representative cross-section of the entire population, such that their per capita income had changed in the same proportion as had that of the total population. A measurement of this change was obtained by linking Kuznets' "aggregate payments to individuals including entrepreneurial savings" to the "personal income" series of the Department of Commerce.[9] Converting this income series to a per capita basis by means of the Census' annual population estimates,[10] one could gauge what had happened to per capita income before direct taxes in the 25-year period under survey here. A further refinement measures per capita income per hour worked. By making use of unpublished National Bureau of Economic Research data on the length of work week of the entire labor force, made available to the writer by Professor Mills, it is possible to convert this measure into per capita income per hour worked.

This measure indicates that per capita money income per hour worked in 1946-49 was at 262.37 percent of its 1921-24 level. Taking this fact in conjunction with the change in the amount of service rendered, and the money paid for it, leads to the conclusion that the real cost to passengers per unit of service had declined in 1946-49 to 27.5 percent of its 1921-24 level. This could also be expressed by saying that to buy a passenger-mile of transportation in the later period would require a passenger to spend only about 27.5 percent as much of his time in earning the necessary price as would have been required in 1921-24.

Next, an analogous measure for the freight patrons of the railroads had to be determined. The figures show that revenue ton-miles of freight and the dollar revenue received for carrying freight increased in almost exactly the same proportion. Thus, per ton-mile of freight, the revenue received by the railroads was about the same in both periods. Since, in general, the prices of commodities carried by freight increased considerably, the cost of freight service represented a much smaller proportion of the value of the commodities carried in the later period. One of the most difficult tasks in this entire study was the determination of the proper index to reflect what happened to prices of commodities carried. Ideally, one should

[9]Kuznets, Simon S., **National Income and Its Composition,** 1919-1938, National Bureau of Economic Research, New York, 1941; U. S. Department of Commerce, **National Income Supplement to the Survey of Current Business,** 1951 ed., 1951.

[10]U. S. Department of Commerce, Bureau of the Census; for 1921-24: **Statistical Abstract of the United States,** 1942, p. 11; for 1946-49: **Current Population Reports,** Release P-25, No. 48, March 22, 1951.

have the price of each commodity entering into costs of freight transportation in both periods, constructing an index by applying weights representing the value of the commodity carried in the later period. Although adequate data do appear to be available, this was too great a job for the present purpose. Thus, as an alternative, the actual measure used here was obtained by using the Bureau of Labor Statistics' Wholesale Price Indexes for various commodity groups and weighting them by the importance of these groups in railroad freight rather than by their importance in the economy as a whole. This procedure yielded a price index of 161.85; the combined index of the Bureau of Labor Statistics, if adjusted to represent the same two periods, would be 154.20. The measure developed here is higher because some commodities, showing a greater than average price rise, received more weight in this index than in that of the Bureau of Labor Statistics for the reason given. Such commodities include grains, bituminous coal, lumber, and cattle feed. Moreover, certain products exhibiting less than average price rises were given lower weights in this index because of their relatively lesser importance in railroad freight. Among these commodities were included miscellaneous farm produce, such as fruits and vegetables, and textile and petroleum products.

It would be reasonable to attempt to adjust the cost of railroad freight even further by appraising the amount of effort going into the production of the commodities carried, but such treatment would have required an elaborate study of productivity in practically all industries and was also beyond the scope of present study. Applying the price measure just mentioned in conjunction with the money paid to the railroads and the volume of freight traffic, one may conclude that the real cost per unit of service to buyers of freight service in 1946-49 was 61.8 percent of the 1921-24 base. A summary of the measures relating to passengers and to purchasers of freight service appears in Table 3. In this same table, a weighted average of the freight price index and the per-capita-income-per-hour measure is shown. This measure represents the "prices" received by the patrons of the railroads for their own contributions to society in a broad sense. The measure is, of course, much closer to the freight price index because it is freight revenue that accounts for by far the greater proportion of the railroads' receipts. The most conspicuous item of information in this table is the much greater relative reduction of real cost of service to passengers than to freight buyers.

TABLE 3

Real Costs of Service to Railroad Patrons, 1946-49

(1921-24 = 100)

	1946-49 as a Percent of 1921-24
Passengers:	
Passenger revenue	89.63
Per capita income per hour worked	262.37
Passenger miles	124.41
Real cost, aggregate service	34.2
Real cost per unit of service	27.5
Freight buyers:	
Freight revenue	168.49
Prices of commodities carried	161.85
Revenue ton-miles	168.41
Real cost, aggregate service	104.1
Real cost per unit of service	61.8
Total combined traffic:	
Physical volume	159.27
Revenue	152.12
Revenue per unit	95.51
"Prices" received, all patrons	174.15

To this point this analysis has been concerned with indicating the relative gains in real rewards to the railroads and their employees and the relative reduction in real cost to the customers of the railroads. Several questions are still unanswered. For example, what have been the relative gains of the railroad stockholders, of suppliers of equipment and materials to the railroads, and of the government through taxes collected from the railroads? These questions are diffi-

TABLE 4

Summary of Railroad Productivity Related to Real Rewards and Costs for 1946-49 as Compared with 1921-24
(1921-24 = 100)[1]

	1946-49 as a % of 1921-24
q, revenue traffic (Table 3)	159.27
e, manhours, all employees (Table 1)	72.15
s, revenue for transportation service (Table 3)	152.12
p_1, prices of goods carried by freight, combined with passenger incomes (Table 3)	174.15
p_2, prices paid by railroad employees, (Consumer Price Index)	132.68
q/e, output per manhour	220.7
e/q, real cost in hours of one unit of service	45.30
s/q, revenue per unit of service	95.51
s/e, money returns per hour worked	210.8
s_1 - s/p_1, real cost of aggregate service to patrons	87.35
s_2 - s/p_2, real rewards to railroads for aggregate service	114.7
s_2/e, real rewards to railroads per hour of work expended	159.0
q/s_1, service obtained by patrons per unit of real cost to them	182.3

[1]The letter symbols follow those of Mills, F. C., **Journal of American Statistical Association,** June, 1937, **loc. cit.**

cult to answer, primarily because it is hard to evaluate the physical contribution made by these groups for the payments received. For example, although hours of work have been utilized to measure the employees' contribution, it would be difficult to arrive at any analogous measure of the contribution of the stockholders in terms of their investment in the railroads. It would also be difficult to determine the contribution of long-lived depreciable equipment to the operations of any one year in physical terms. Nevertheless, some light is cast on the relative benefits to these groups later on.

Table 4 summarizes the pertinent data already developed. The letter symbols used indicate how the measures of real cost and real rewards were derived from the basic data explained above. The last two lines in the table represent the rewards accruing in real terms to the railroad organization and to the customers, respectively. The implication is that the railroads have gained 59 percent, in terms of real goods purchasable with the railroad revenue, for every hour worked by railroad personnel, and that the patrons receive 82 percent more service per unit of real cost to them. It will be recalled that real cost to passengers is expressed in terms of the time required by them to earn the money required to pay their fares, whereas for freight patrons real cost is measured by the proportion of the price received for commodities carried that must be paid to the railroad per ton-mile hauled. An examination of the symbols representing the last two items in the table shows that if they are multiplied together they should yield $\frac{q}{e} \times \frac{P1}{P2}$ In other words, by multiplying together the relative benefits to the railroads and to their customers, the productivity change, namely q/e, multiplied by a ratio of the prices affecting the two groups may be obtained. Thus, the benefits attributed to the railroads on the one hand and to their customers on the other are attributable partly to the productivity change and partly to the fact that the groups will have been differently favored by the general price movements that affect them. The fact that the prices

of goods carried by freight combined with the increase in passenger incomes per hour of work have gone up by more than the prices paid by railroad employees for goods and services (174.15 as compared with 132.66) means that the customers have been favored in their dealings with the railroads merely by the operation of the price system. If the prices which the railroad patrons receive for what they had to sell had gone up no more than the prices paid by railroad employees for things they had to buy, the railroad patrons would have appeared to have benefited less than the employees. Possibly the most relevant contribution to current discussions on the subject is that, in response to a 120.7 percent increase in productivity, the real rewards per hour of work to the employees rose less than 60 percent, while the real cost of a unit of service to the customers fell by more than 40 percent.

A DOLLAR EVALUATION OF PRODUCTIVITY INCIDENCE

The significance of the productivity change and its impact on the various groups concerned may be approached from a somewhat different point of view, by attempting to indicate in dollar terms what saving in labor costs is attributable to the gain in productivity. To this end, some of the financial data published by the I.C.C. for Class I railroads as a whole must be examined. Since this measure of productivity is focused on the traffic carried by train, inclusion of data on revenue costs, and the like, pertaining to other aspects of the railroad business, such as water, transfers, dining room and hotel operation, storage, rents from real estate owned, and investments must be avoided. In order to confine the data to the train-operation aspect of the railroad business, certain adjustments have been made, which could probably be refined by a more detailed study of the railroad accounting system. Passenger and freight revenue has been considered chargeable with operating expenses and such taxes as are assigned by the railroads to these expenses, only in the proportion (which is, however, quite large) which passenger and freight revenue bears to total operating revenue. Further, fixed charges, such as interest on bonded debt, are deemed to be paid out of passenger and freight revenue in the proportion that net income remaining from such income bears to the total net income from all sources available for payment of such charges. Similarly, net profit accruing to stockholders and the dividends paid to them are considered ascribable to the passenger and freight revenue in this same proportion. It is necessary to make some such assumption because actual passenger and freight revenue is a substantially greater part of total revenue in the late 40's than was the case in the early 20's. It would, therefore, be erroneous to ascribe as much of the earlier periods' fixed charges, profit, and so on to the revenue from freight and passengers. Following this line, one is able to show, for each of the two periods under study, the payrolls, taxes, and other expenses, fixed charges, and profits which may be considered to be associated with the passenger and freight revenue of these periods.

The total volume of railroad traffic in 1946-49 was 159.275 percent of its 1921-24 level. Supposing that the railroads had charged the same rates in the later period as in the earlier, their revenue would have risen to 159.275 percent of the base period amount. Further, the number of manhours required to perform the service may also be assumed to have risen in the same proportion, implying that productivity would have remained constant, and, also, that the amount paid per hour of work had not changed. Under this hypothesis, payrolls would have increased in exactly the same proportion as traffic. If it may further be assumed that other expenses, taxes, fixed charges, and profits increased in the same proportion, a norm against which to compare actual happenings would result. In making this comparison, it is necessary first to determine what the change in productivity might be said to have effected. Instead of requiring an increase in man-

hours proportionate to the increase in traffic, the great increase in productivity demonstrated actually reduced the number of manhours required below that of the earlier period. If the 1921-24 hourly rates of pay had persisted and no change in productivity had occurred, the railroads' annual payroll would have averaged $4,096 million in 1946-49. The actual number of hours worked was far less as a result of the productivity increase; if they had been compensated at the average 1921-24 rate of pay, the railroads' wage bill would have been only $1,856 million. The difference between these two figures, $2,241 million[12], may be considered potential saving resulting from the gain in productivity.

What has happened to this potential saving of $2,241 million? First, the actual average payroll allocable against passenger and freight revenue was $3,888 million. The same number of hours of work, as noted above, would have cost the roads only $1,856 million had they still been paying 1921-24 rates. The difference between these two figures, $2,033 million,[12] is due to paying higher hourly rates than prevailed in the earlier period. Moreover, the revenue received in 1946-49 averaged $8,524 million. The difference of $383 million between these two figures is a consequence of reduced charges for railroad services. If the same procedure is followed with other costs, a balanced account showing how savings of one kind or another were absorbed through higher costs, higher taxes, or reductions in revenue may be developed.

A resume of the procedure just described and its results is contained in Table 5.

The balancing of the account for "Sources and Disposition of Margin" in the lower part of Table 5 may give a specious impression of precision, since the balancing is really predetermined by the manner in which the figures are derived. The table does, however, give a meaningful answer to the question of how, on the strength of a 59 percent increase in the volume of business, the railroads could afford to pay so much more money in the form of payrolls and taxes with a revenue that did not rise even in proportion to the increase in traffic. The answer to this question is that, in order to get the necessary work done, the road required far fewer hours of labor; moreover, certain costs other than taxes and payrolls did not go up in proportion to traffic; stockholders' profits did not rise proportionately; neither did fixed charges rise proportionately. The weak point in the presentation is primarily that we cannot say whether the reduction in other costs was in response to a reduced need for the physical requisites which they represent, or to paying a lower price for the same quantity. Similarly, we cannot say whether the lower profits per unit of railroad service represent essentially a lower payment for the same degree of "sacrifice" on the part of the stockholders, or whether the higher taxes represent a greater quantity of government service or, conversely, a higher payment for the same quantity. This last point would in particular raise many controversial questions. What the data do show is the extent to which the payments to employees represented a different quantity of service, and the extent to which they were due to an increase in hourly rates of pay. As compared with the index number presentation in Table 4, it is noteworthy that higher pay rates to employees, aggregating to $2,033 million, greatly outweigh the reduction in revenue, valued at $383 million, resultant from lowering of fares and rates. This is in sharp contrast to a showing, in Table 4, that the patrons received a greater relative benefit. There is no real contradiction here inasmuch as the effects of prices paid by employees and those received by railroad patrons are in no way allowed for in the Table 5 presentation, where only aggregate dollar effects are under consideration.

[12]Discrepancy in the last digit is due to rounding.

TABLE 5

An Appraisal of the Dollar-Effect of the Productivity Rise[1]

	Col. I Actual 1921-24	Col. II Actual 1921-24 x 1.59275[2]	Col. III Actual 1946-49
Passenger and freight revenue	5,352[3]	8,524	8,141[3]
Payrolls Allocable	2,572	4,096	3,888
Taxes	287	457	813
Expenses other than payroll and taxes	1,647	2,624	2,540
Fixed charges	494	787	394
Profit accruing to stockholders	351	560	505

Derivation of the productivity margin:

(A)	Aggregate hours of work, 1946-49	3,206,742,000 hours
(B)	Average pay per hour, 1921-24	63.3178 cents
(C)	1946-49 hours x 0.91388[4]	2,930,577,000 hours
(D)	Payrolls, had the 1946-49 hours been paid for at the 1921-24 rates. (C x D)	1,856
(E)	Payrolls, had the same productivity level prevailed in 1946-49 as in 1921-24, at 1921-24 rates. (Above, Col. II).	4,096
(F)	The productivity margin — payrolls saved by the rise in productivity, at 1921-24 rates of pay. (E minus D)	2,241[3]

Sources and Disposition of "Margin":[5]

Sources		Disposition	
Rise in Productivity	2,241	Higher pay rates to employees	2,033
Reduction in costs other than taxes and payrolls[6]	84	Higher taxes	356
Lower profits accruing to stockholders[6]	54	Reduction in revenue through lower fares and rates	383
Lower fixed charges[6]	393		
	2,772		2,772

[1]All data are in millions of dollars unless otherwise noted.

[2]Ratio of increase in traffic, 1946-49 as compared to 1921-24.

[3]Fails to agree in last digit because of rounding.

[4]The ratio which passenger and freight revenue bears to total operating revenue; thus, line e shows hours adjusted downward to an amount applicable to passenger and freight revenue only.

[5]The margin due to productivity was derived in f just above; the disposition through higher pay rates to employees is (except for rounding) the 1946-49 payroll, Col. II above, minus line d. All other items in this section are obtained by subtraction of corresponding items in Cols. II and III above.

[6]That is, lower in relation to the volume of service rendered by the railroads.

CONCLUSIONS

It may be worth while to bring together the salient results of this study. Railroad productivity more than doubled between 1921-24 and 1946-49. This was accompanied by substantial increases in pay rates, but also in the prices paid by employees for goods and services. Thus, per hour worked, the average railroad employee received 56.4 percent more real income. The customers of the railroads also benefited, since for passenger and freight traffic combined they obtained something like 82 percent more service per unit of real cost to them. The discrimination in favor of the customers may be attributed to the fact that the prices of what they had to sell rose by more than those of what railroad employees must buy. Distinguishing between groups of employees, it was noted that the nonsupervisory employees, whether in operations, maintenance, or office work, were much more favored than the supervisory and executive groups. As between the passengers and the purchasers of freight service, it was concluded that the passengers were much more favored, a finding that is subject to some doubt if actual hours of effort rather than physical commodities were used to gauge the sacrifice of the freight buyers. In dollar terms, some light has been cast on the fortunes of other groups associated with the railroads, the rise in productivity being the principal factor enabling the railroads to pay higher rates to employees, higher taxes to government, and to receive less revenue per unit of service rendered. Productivity, however, was not the only factor, since, per unit of railroad transportation service, other costs, the profits of the stockholders, and fixed charges, showed a material reduction.

In conclusion, it is here pertinent to emphasize that, with a productivity increase of some 120 percent, real income of railroad employees per hour worked rose by only about 56 percent. Had the real hourly income of employees risen in the same proportion as did productivity, even assuming that consumer prices would not thereby be affected, the railroads would have been unable to reduce their revenues per unit of service, but on the contrary, would have had to increase them very substantially. This statement should not be taken to imply a conclusion as to what ought to be done in response to productivity increases; it does show, however, that in this important industry, increasing real wage rates in proportion to the rise in productivity would have meant a very different structure of costs and of prices charged than has actually prevailed in the past 25 years.

Operations Research Applied to Business Problems

by ROSELLA JAMES*

A discussion of the application of research methods to the formulation of business policy and problem solution, the article describes scientific methods of providing executive departments with quantitative and qualitative bases for making decisions on operations under their control.

"OPERATIONS research is a scientific method of providing executive departments with a quantitative basis for decisions regarding the operations under their control."[1] On first reading the definition of operations research, a businessman might very well be inclined to think that he already is using the concept. Certainly, in many businesses there is a plethora of numerical data designed to aid the executive. Operations research, however, differs in point of view, approach, and continuity of action from accounting procedures, engineering functions, "efficiency expert" activities, and most other methods of analysis found in present-day industry. Introduction of operations research into a firm, because of greater utilization of existing data and the setting up of numerical measures for processes not yet thought subject to quantitative analysis, should result in greater efficiency, lower costs, and increased sales.

It was during World War II that the term operations research, sometimes called operations analysis or evaluation, came into prominence, although prior to that time the method had been employed in scattered areas of industry, economics, government, and military activities. During the war, the method was developed and applied systematically by teams of scientists who devoted themselves to solving specific military problems. Their efforts were directed not toward introducing new equipment, but toward mathematical analysis of the uses of existing equipment in order to suggest changes in arrangements or procedures. For example, logic would seem to indicate that a small group of ships, compared to a large number, would be more difficult for a submarine to find and, if found, harder to hit because of the smaller target presented. Yet analysis of existing data showed that a smaller average loss resulted with larger convoys.[2] In another instance, a sharp increase in aircraft engine failures almost led to a decision to increase the frequency of maintenance check-ups and overhauling. Closer examination of the data revealed that most of the failures were occurring in engines which had been overhauled or repaired only a few hours before the failure. The solution lay not in increased maintenance but in reorganization and training of the maintenance workers.[3]

The success of the systematic application of scientific method and techniques during the war has stimulated interest in adapting operations research to fields outside the military. Business is one of the areas where the procedure can be used to advantage.

STARTING OPERATIONS RESEARCH IN A FIRM

Operations research is a continuous process. Its workers are constantly checking established measures against performances, looking for new problems, and computing measurements to aid in the solution of questions asked them. Some of their work may overlap with that at

*Rosella James is a member of the Statistics Faculty of the Temple University School of Business and Public Administration.

[1]Morse, Phillip M., and Kimball, George E., **Methods of Operations Research**, New York, The Technology Press of Massachusetts Institute of Technology and John Wiley & Sons, July, 1951, p. 1.

[2]**Ibid.**, p. 46.

[3]Volunteered during discussion period, Joint Meeting of the Philadelphia Chapter of the American Statistical Association and the American Marketing Association, November 16, 1951.

present performed by other departments, but for the most part operations analysis starts where the activities of others end.

Separate Department

The first step in beginning such a program would be to set up a separate department. The existence of one department offering assistance in solving all types of problems is an advantage in itself. In addition, the objective point of view required of operations research workers and the independent position of the research department within the firm's organization precludes the possibility of combining operations research with any existing department.

An operations research employee should be in direct communication with the executive having control over the operations to be analyzed. This is necessary, first, so that the problem may be understood better by the research worker. Secondly, the results of the analysis are often technical and require explanation of their various aspects. The decision to follow suggestions or not is entirely the prerogative of the executive who must consider many other factors such as general management policies, psychological reactions, and general economic conditions. Before reaching his decision, however, he should have a complete understanding of the quantitative results of the analysis. If a technical measure has to be passed along through several persons who do not understand it before reaching the executive, it loses its effectiveness.

Personnel

Although a few universities are beginning to offer courses in research, there are as yet few if any formally trained workers available. There are individuals, however, who have had either experience in the field or a background which would enable them to adapt themselves to the program.

Although a general acquaintance with business procedures and subjects would be desirable to help the employee more quickly to become familiar with the ramifications of data with which he must deal, the operations research worker need not be an expert in any field of industry. The first and primary requisite is a scientific viewpoint which is rather difficult to describe. It involves objectivity and impersonal curiosity combined with a knowledge of scientific method. It is an attitude of mind resulting from a combination of personal psychological factors and scientific training. An operations research worker, then, should have had scientific training. In addition, he should have a thorough knowledge of statistical methods of analysis.

His personality, too, is important. He must in many instances explain rather technical statistical measures to executives with nonmathematical training. If he is incapable of making himself clear in nontechnical language, much of his work will be useless.

OPERATIONS RESEARCH'S APPROACH TO A PROBLEM

Operations research is a **scientific method.** It is a way of approaching and solving a problem. It can, as can any scientific method, be said to include four steps: (1) recognition of a problem; (2) analysis of observed data associated with the problem; (3) generalizing or theorizing from the results of the analysis; and (4) applying the generalization to similar events. Sir Isaac Newton and the apple illustrate the process. (a) He recognized the problem of earth's attraction for objects by noticing the apple fall. (b) He measured rates of fall for different objects. (c) From the data, he theorized about earth's attraction for all objects. The theorizing produced, of course, the law of gravity. (d) The law of gravity has been applied to many practical problems having nothing to do with apples.

Recognition of a Problem

Often the greatest contribution of operations research is in recognizing that a problem exists. Sometimes the problem is quite simple and is noticed only because of the different point of view with which research approaches it. For example, all firms have a labor turnover which is costly since new workers must

be trained. The firm may take for granted that the rate of turnover is not excessive. Operations research would, in the normal course of its activity, compare the company rate with rates for the industry, competitors (if possible), and the whole economy. In addition, the quit rates of various departments within the firm would be studied, and those departments for which the rates are too large would be investigated.

In a recent case, statistical results for a merchandising concern's advertising were highly satisfactory. Analysis showed, however, that advertising was being sent primarily to already satisfied customers who possibly would have responded as much to less advertising. The question was then raised as to whether it would be more profitable to investigate dissatisfied former customers and to direct advertising toward persons who were not yet customers.[4]

Analysis of Observed Data

Mathematical methods range from the simple to the highly complex. Since most of the data are uncontrolled, as compared to laboratory experimental data, the methods and theories of statistics which are designed for analysis of such values are most often used. Tabulation, graphic presentation, ratios and percentages, sampling theory, frequency distributions, time series, correlation, analysis of variance, and probabilities are all included, of which perhaps the most useful are probabilities.

The following brief descriptions of some of the less-known types of analysis will aid not only in understanding the actual work of operations research, but also in distinguishing its analyses from those of other departments.

Sampling theory, in general, proceeds under the assumption that the measurement of part of a whole will be similar to the whole, which in statistics is called a population or universe. From the sample measurements, characteristics of the population may be inferred. The assumption is valid, however, only if the sample is a random one drawn from an homogeneous (alike as to pertinent qualities) universe. A sample is said to be random if every item in the universe has an equal chance of being drawn. There are variations on random sampling such as area sampling and stratified sampling, but basically the random method is employed in collecting the data within an area or a stratum. Sample data are secured rather than population data when it is physically impossible to obtain population items or when costs must be considered. The sample data are analyzed by means of methods just named.

In **frequency distribution analysis**, values are grouped together within value limits instead of being analyzed as individual items. In other words, the frequency with which values occur between certain limits is stated. For example, if there are eight salaries between $30.00 and $49.99, the range between these values is called an interval. Normally, each distribution will have from five to thirty intervals. Arrangement of the data into a frequency distribution not only saves labor, but also forms a better basis for computations of inferred population values than do the separate items themselves. The characteristics of the frequency distribution are described by a comparatively few measurements. There is the tendency of many kinds of data to be concentrated around central values (central tendency) which is described by means of averages such as the arithmetic, the geometric, and the harmonic means, the median, and the mode. Spread of the values (variability) is shown by a number of different measures, the best known and most easily computed being the range or the difference between the highest and lowest values. There are other measures designed to portray asymmetry (propensity for values to be concentrated either on the low or high side) and the height of the distribution (inclination of curve to be peaked or flat compared to mathematical models).

In **time series**, data collected at different points in time are separated into component parts attributable to long-term

[4]Morse and Kimball, **op. cit.**, p. 6.

influences (secular trend), seasonal factors, business cycle, and irregular elements. The chief use of the method is to predict the future from studying the past.

Correlation expresses the kind and degree of relationship between two or more sets of data. If past sales are correlated with advertising expenses, value of future sales at a specified proposed advertising expenditure may be estimated within limits. The limits would depend on the closeness of the past relationship. Correlation is used, too, to find controlling elements and to determine causes of difficulties. In one company, because of complaints about the stenographic department, the average number of pages typed per day was correlated with wages of the stenographers and length of time with the company. Results were surprising. There was little correlation between work and wages, and there was negative correlation between work and length of time with the company. Negative correlation indicates that when one type of value is high, the other is low and vice versa. Apparently the longer a stenographer stayed with the company, the less work she accomplished. Part of the reason may have been the lack of relationship between work and salary. Also further investigation revealed personality difficulties between the supervisor and the other stenographers. Both of the above examples show a causal relationship. Cause, however, need not be direct. As an illustration of a noncausal relationship, future business cycle influences on a company's sales may be estimated by correlating, with a time lag, sales and some activity in another part of the economy which is affected prior to the sales of the company performing the analysis. Here there is no direct causal relationship, although both sets of data may be influenced by the same set of factors.

Analysis of variance has to do with testing whether several sets of figures have essentially the same variability. A classic example is that of different types of corn, planted in different kinds of soil, with different types of fertilizer used, all being tested at once. By designing the experiment properly, the one test will indicate whether there is a significant difference among types of corn, among kinds of soil, and among types of fertilizer.

Probability underlies all of the methods described above. Results are never precise and can be stated only in terms of probability. This involves the numerical expression of what events are likely to occur under different sets of circumstances. No matter how complicated it may seem to become, this concept rests on three fundamental theorems.

1. Simple probability is the number of events considered to be successful divided by the total number of possible events.

   Example: In tossing a six-sided die, the probability of getting any one side is 1/6.

2. The probability of either one event or another event happening is obtained by adding the simple probabilities.

   Example: In tossing a six-sided die, the probability of getting either a four or a five is 2/6 or 1/3. Note: The probability of getting all sides would be 6/6 or 1. The total probability or certainty is 1.

3. The probability of events happening either together or in sequence is obtained by multiplying the simple probabilities.

   Example: The probability of getting a four on the first toss of a six-sided die and a five on the next toss is $1/6 \times 1/6 = 1/36$.

Quantitative Analysis. One of the important functions of operations research is the reduction to numerical values of some processes which are not usually considered subject to quantitative analysis. Within the past few years, flavor has been measured. It is done with panels of expert tasters, chemical analysis, and graphs. Practical consequences have ensued — Frigidaire redesigned its refrigerator to prevent flavor transference; a liquor company decreased its formerly large sales returns to an almost infinitesimal amount; a brewery, finding its product "too good," increased sales by

reducing its thirst-quenching properties.[5] Taste measurement can be considered part of quality control when used merely to maintain the product at a given flavor, but it goes into the realm of research operations when applied to improving the product.

Generalization of the Results of the Analyses

Not all problem solutions can be generalized to apply to other situations, but many can. The illustration of flavor measurement above may also be used as an example of generalization of results. Two concerns, Arthur D. Little, Inc., and Distillers Corporation — Seagrams, Ltd., are the leaders in developing the measurement. Having developed ways to measure flavor in one product, both companies now do work for other companies with a variety of products.[6]

Applying the Results

Operations research is an applied science. It utilizes scientific method and techniques to solve specific problems. It uses data from external sources and from internal departments, accounting, engineering, quality control, time and motion, and sales, in order to derive constants for controlling and judging numerous activities. Yet the operations research worker himself should not be the one to decide whether his results are to be put into effect. A large part of his value depends on his objective viewpoint. The necessity for a decision maker to balance quantitative results, psychological factors, economic elements, political considerations, and company policies is antagonistic to an impersonal approach. It has been found from experience that, although the operations research scientist may become an efficient executive, his worth as a research worker deteriorates.[7]

OPERATIONS RESEARCH AND BUSINESS ACTIVITIES

The possible business applications of operations research are infinite; a list of areas where the process might be useful would include almost every one of the myriad functions of all types of business. The following suggestions are, therefore, only a partial survey of the many possible uses. In some cases, the work of compilation may already be performed by the statistics or other departments. Operations research would be associated with such work in the capacity of checking, reviewing, and bringing its distinctive contribution of an objective, scientific viewpoint to bear on the analysis.

General Management

General management must formulate its policies on the basis of conditions which are expected to develop in the future. External as well as internal affairs should be considered. Although the executive who does not have quantitative data to aid him may consider expected external conditions, his decisions are more likely to be erroneous than the executive who has numerical measures to guide him. Statistical methods may be used to forecast not only company, but also industrial and economic conditions. Some companies have been using such measures for years, planning their activities to take advantage of business cycles.

Internal affairs can then be planned using forecasted external conditions as a foundation. Statistical methods again aid in deciding on future sales forecasts and policies, wage plans, budget values, financial questions, and long-term expansion projects. Most companies now forecast some of these operations, but not necessarily by means of statistical methods. In predicting sales which, in turn, form the basis for numerous other decisions, for example, many companies employ a sort of intuitive process, whereby past performance is combined with what the salesmen and sales manager think will happen, to arrive at a forecast for the future. Under operations research, what should happen as well as what has happened would be considered. The methods of time series and correlation, chiefly, would be employed to investigate all major elements affecting sales. These would include long-term trend, seasonal

[5] **The Wall Street Journal**, September 26, 1950, p. 1.
[6] **Ibid.**
[7] Morse and Kimball, **op. cit.**, p. 2.

fluctuations, stage of the business cycle, irregular influences, (taxes, union agreements, government regulations), new products, competition, consumer habits and preference, population, and purchasing power of different sales areas. In the past such studies have been known to reveal the fact that apparently star salesmen have not been selling as much as the sales potentialities of their territories would indicate, while other salesmen with low company ratings have been obtaining maximum results from the poor territories assigned them.

Personnel and Industrial Relations

Job tests, aptitude tests, job evaluation and analyses are already practiced by many large companies. Even if these concepts are being used, operations research can supplement the work by following through to check the consequences. To illustrate: samples of actual work performance may be correlated with test scores. If little relationship between the two exists, further inquiries should be made.

General Office

General office work in the past has not usually been analyzed quantitatively. Close examination, however, often discloses operations which can be measured. An example was cited earlier of a correlation analysis among stenographers' average number of pages typed, wages, and length of time with the company. In that instance, the average was computed from actual work done by the stenographers over a two-week period with weights being given for different kinds of material typed. In addition, a standard was set by studying normal typing speed for a typist with allowances for dictation and breaks between jobs to allow for mental readjustment.

Purchasing

Studies of transportation rates, forecasted price level changes, marketing forecasts, and quality comparison tests may be used to advantage to obtain more efficient and effective purchasing. For example, products of essentially the same quality may be offered at different prices. Operations research would test for any significant difference between the products using reliability and significance tests or analysis of variance. If there is no significant difference, the lower-priced item would be purchased.

Production

If a company has installed complete quality control, most of the work of operations research has already been accomplished in production. In other words, the production system has been analyzed statistically for inefficiencies. If inspection of the product only is being used, however, operations research would still have much to do in studying more efficient arrangements of machinery and the elimination of bottlenecks.

Marketing

The field of marketing has been one of the most fertile for statisticians. Consumers' research and the testing for effectiveness of advertising are familiar to most people. In this area, operations research would try to answer the questions: What can be sold? Where can it be sold? How much can be sold? Can the amount of sales be increased by changes in the product or in advertising? The answers would be supplied by analyses of consumer reactions to new products, changes in the old, and to advertising, population, purchasing power, consumer habits, economic conditions, and by a time series analysis of past sales. Within the gross sales forecast, sales territories and sales by product would be analyzed to permit rating a salesman and to point out to him where his weaknesses lie.

CONCLUDING OBSERVATION

Many aspects of operations research are not new. Attempts have previously been made to apply scientific method to business functions. Statistical theory also has penetrated some parts of business data analysis. The contribution of operations research, however, lies chiefly in the directing of attention to the effectiveness of the scientific method and statistical techniques when they are applied with a sustained effort from a central point.

Philadelphia Business Index

The September 1950 issue of the Bulletin presented a new index of general business conditions in the City of Philadelphia. This series, prepared by Robert T. Kline, and designed to reflect economic activity exclusively within the boundary of the city, was based upon a combination of statistical data representing (1) industrial electric power sales; (2) indexes of employment and employee-hours; (3) department store sales[1]; (4) bank debits; and (5) total construction. Because the method of reporting certain data is under revision by the originating agency, the change in average weekly hours worked and the monthly change in total employment in the Philadelphia metropolitan area, both prepared by the Pennsylvania Bureau of Employment and Unemployment Compensation, have been substituted for (2) above. This is a temporary expedient to maintain continuity of the index. The original data series will be restored after revision.

The following table presents the index for the years 1939 through 1951 and by month from January, 1952.[2]

Index of General Business Conditions, City of Philadelphia, 1947=100

Year	Index	1952 Month	Index
1939	73	Jan.	109.2
1940	77	Feb.	108.2
1941	96	Mar.	109.5p
1942	99		
1943	106		
1944	106		
1945	98		
1946	100		
1947	100		
1948	103		
1949	97		
1950	108		
1951	111		

[1]The revised index of Department Store Sales, published by the Federal Reserve Bank of Philadelphia, has been used in the composite index since October, 1951. The revised Wholesale Price Index, all commodities, published by the BLS, is used beginning January, 1952 as a deflationary index for the Bank Debit Series.

[2]Robert T. Kline, "A Measurement of General Business Conditions in the City of Philadelphia," **Economics and Business Bulletin,** School of Business and Public Administration, Temple University, Philadelphia, Pa., September, 1950, pp. 33-40.